DEFENCE TURKEY

VOLUME 13 ISSUE 92 YEAR 2019
ISSN 1306 5998

AN OVERVIEW OF THE ONGOING SPACE PLATFORM AND SYSTEM PROJECTS IN TURKEY

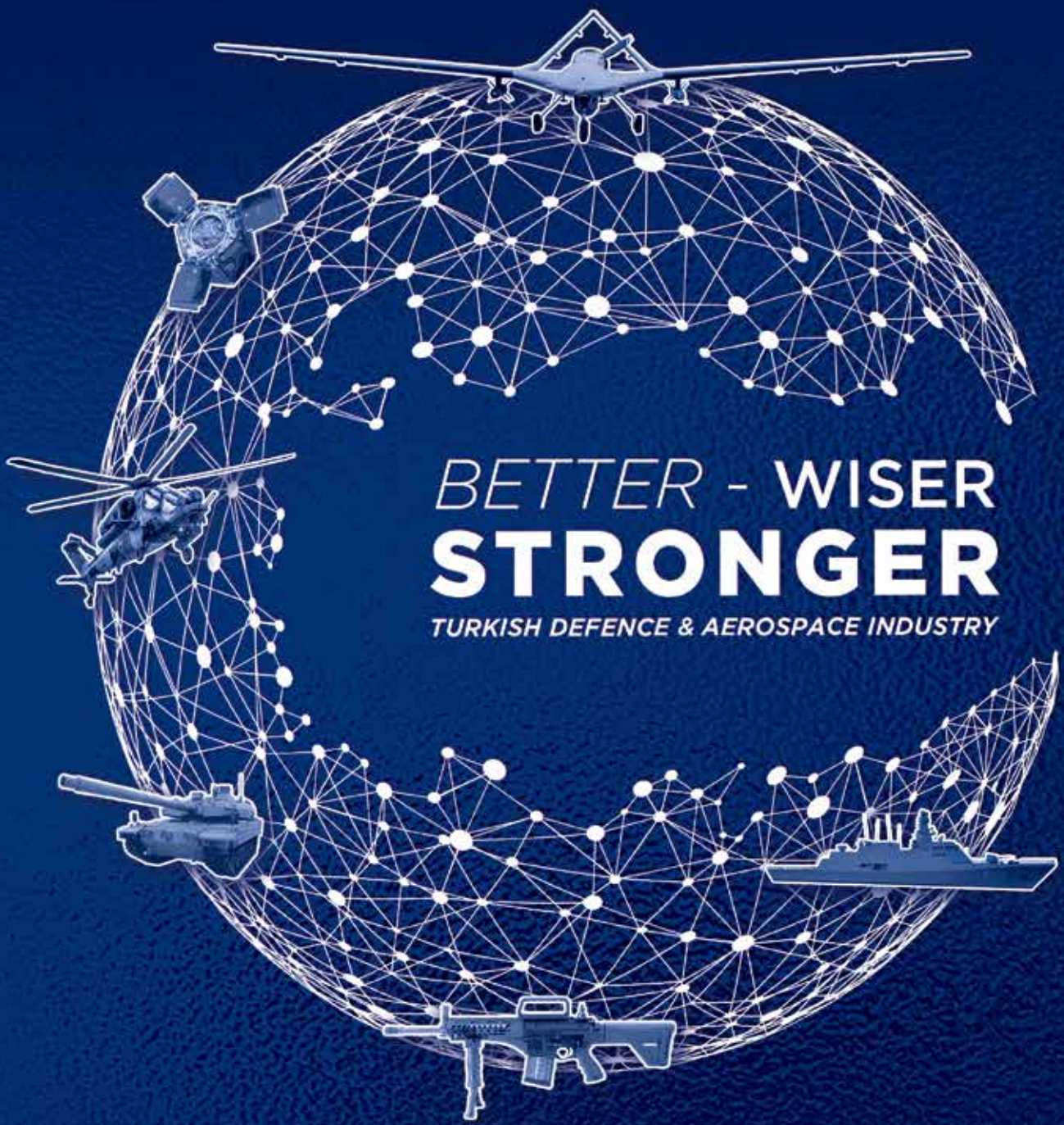
THE LAST A400M FOR THE TURAF WILL BE DELIVERED IN 2022!

A LOOK AT THE TURAF'S ONGOING FIXED WING JET POWERED AIR PLATFORM PROGRAMS

SHAPING THE FUTURE OF EUROPEAN AIR DEFENCE - EUROSAM OPENS A NEW CHAPTER FOR TURKEY

COLLINS AEROSPACE READY TO TEAM UP WITH LOCAL TURKISH COMPANIES

AEROSPACE SPECIAL ISSUE



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DEFENCE TURKEY

VOLUME: 13 • ISSUE: 92 • YEAR: 2019

ISSN 1306 5998

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Basım Tarihi
Haziran 2019

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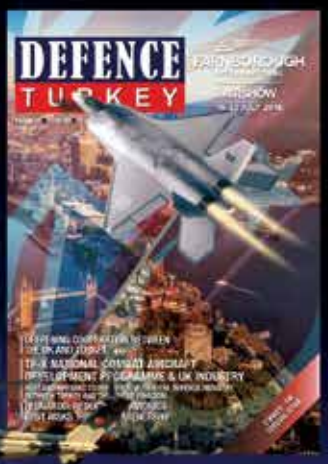

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Turkish Aerospace Revealed a Mock-up of Turkish Fighter at Paris Airshow

Ayşe Evers
Publisher & Editor in Chief

During the Paris Air Show, on 17 June 2019 Turkish Aerospace unveiled a full-sized mock-up of its next generation fighter the Turkish Fighter.

Speaking at the one to- one mock-up of a Turkish Fighter aircraft presentation, it was stated that when it enters service, the Turkish Fighter will be "the best fighter in Europe" and will be capable of carrying the longrange, air-to-air METEOR missile of the European manufacturer MBDA. President & CEO KOTİL disclosed that the aircraft would be completed in 2023, with first flight in 2025 and the next generation fighter will enter the service of the Turkish Air Force (TurAF) in 2028. It is also stated that once the Turkish Fighter is developed, Turkey will become the world's fourth country to have this type of aircraft.

According to reports, the fullsize mock-up Turkish Fighter, which was constructed in 35 months in Germany by recently established Turkish Aerospace-KALAY Joint Venture Company.

In order to meet Turkish Air Force (TurAF) requirements beyond 2030, TF-X, the Development Program was launched inaccordance with Decision of Defence Industry Executive Committee meeting (DIEC) dated 15 December 2010. The MMU/TF-X was planned to replace the F-16C/D Fighting Falcon combat aircraft during the 2030s and Turkish Aerospace (Turkish Aerospace) was selected as the Prime Contractor. BAE Systems and Turkish Aerospace signed a US$156 Million agreement to collaborate under the Preliminary Design (Phase-I Stage-I) Phase of the MMU/TF-X Program. The Turkish Aerospace-BAE Systems Collaboration Agreement became effective on 25 August 2017. The 4-year schedule for the Preliminary Design Phase is expected to cost around US$1,3 Billion.

I believe that this ceromony is one of the miles stones of the program and during next period Turkish Aerospace will demonstrate sound achievements in global platforms.

Enjoy this issue… ■

An Overview of the Ongoing Space Platform and System Projects in Turkey

The Turkish Air Force (TurAF), taking an important step in the field of reconnaissance and surveillance with the GOKTURK-II Electro-Optical (EO) Reconnaissance and Surveillance Satellite Project, will also become one of the world's prominent Air Forces in space with the introduction of Satellite Systems for Reconnaissance and Surveillance, such as GOKTURK-I EO, GOKTURK-III SAR and GOKTURK Replacement Satellites. In this article, we will look at the major military communication and earth observation satellite projects in our country and the national infrastructure established in this area, and we will share the latest information with you

Reconnaissance and Surveillance Satellite System (GOKTURK-1)

The GOKTURK-1 Contract was signed between the Italian company Telespazio SPA and the Presidency of Defence Industries on July 16, 2009 and the contract entered into force on July 19, 2010. The project includes; a satellite with an electro-optical (EO) payload, Main Ground Station, Mobile Backup Ground Station and the installation of TAI (now Turkish Aerospace Industries) Space Systems Assembly Integration and Test Center (USET/AIT) to be established on Turkish Aerospace Industries' premises. The satellite is capable of collecting images in Panchromatic (PAN, black and white) at a 0.5m spatial resolution, and 4-band Multispectral (MS, full color) at a 2m spatial resolution, was the highest resolution satellite system procured on international market at that time.

The GOKTURK-1 Electro-Optical (EO) Reconnaissance and Surveillance Satellite, capable of collecting very high-resolution images (the image resolution of Satellites is defined as ground sampling distance and Satellites with a resolution of one meter and below are classified as high-resolution satellites) with a resolution of 50cm from any region on Earth without any geographical restriction, was sent into orbit on December 5, 2016, with the Vega Satellite Launch Vehicle (SLV) by Arianespace, from the Guyana Space Center in Kourou, in accordance with the agreement signed between the main contractor Telespazio and Arianespace in June 2013.

Following the necessary test activities for the in-orbit acceptance process of the very high-resolution GOKTURK-1 Satellite, the tasking activities were carried out by the Turkish Air Force (TurAF)'s Reconnaissance Satellite Battalion Command in Ahlatlibel/Ankara.

The aim of the Project is to provide solutions for the needs of many civilian activities such as forest control, tracking illegal construction, rapid assessment of damage after natural disasters, determination of agricultural boundaries and geographical data gathering, in addition to collecting very high-resolution images for military intelligence purposes.

The footage of GOKTURK-1 Satellite over the Galibolli Strait

Thales Alenia Space France (TAS-F) company, the main Subcontractor, was responsible for the development, and installation and integration activities of the space segment, Telespazio (TPZ), the main contractor, carried out equipment level procurement, production, integration, test and validation activities for the ground segment. Turkish companies Aselsan (Satellite Communication, Ground Station, User & Satellite Access Subsystem), Roketsan (Propulsion System), Turkish Aerospace Industries (Local Main Subcontractor) and TUBITAK BILGEM (Crypto) also participated in the project. Turkish Aerospace Industries, which is directly involved in many work packages, also produced satellite structural panels equipped with three thermal control components. The Ahlatlibel Fixed Ground Station and Mobile Ground Station Subsystem Integration activities were carried out with the active participation of Turkish Aerospace Industries and Aselsan.

The development, manufacturing, and test activities of the GOKTURK-1 Satellite were initiated by the company TAS on July 19, 2010, and it was brought to Turkey on May 7, 2015, following its tests in Cannes, France and placed at the AIT Center which was opened on May 21, 2015. The GOKTURK-1 Satellite has a domestic contribution rate of 20%, and since June 2015 it has been subjected to electrical and functional tests in accordance with the environmental conditions in space, under the responsibility of the Main Contractor TPZ with the participation of Turkish Aerospace Industries and Roketsan personnel. In this context, Mass


Computer Generated imagery of GOKTURK-1 Electro- Optical (EO) Reconnaissance and Surveillance Satellite

GOKTURK-I EO Reconnaissance and Surveillance Satellite Technical Specifications	
Orbit	689km, Sun-synchronous 10:30 Equatorial Crossing
Life Span	7 Years
Launch System	Vega SLV
GSD	PAN 0.5m, MS 2m
Standard Image Size	15km*15km
Spectral Bands	Black-White, Red, Green, Blue, Near Infrared (NIR)

Property Measurement Tests, Launcher Compatibility and System Level Functional Tests coupled with Environmental Tests such as Acoustic, Shock, Vibration, Thermal Vacuum, Electromagnetic Compatibility (EMC) and Deployment of Solar Arrays which were carried out at AIT Center. The GOKTURK-1 Satellite was sent from Turkish Aerospace Industries facilities with a Cargo Plane to French Guiana, where the launch took place, and reached the Guyana Space Center in Kourou on October 24, 2016. Following necessary preliminary work, refueling of GOKTURK-1, which was placed inside the fairings of the AVUM Module, the fourth stage of Vega SLV, was completed on November 9 then transported to the launch site on November 22, and integration of the Satellite to the 30m-long Vega SLV was carried out on November 23. SSB and TurAF personnel were present and witnessed the entire launch operation at the Guyana Space Center in Kourou.

The wet mass of GOKTURK-1 is approximately 1,000kg and the satellite measures 4.2m x 2.5m x 1.6m, featuring a pair of solar panels and a very high-resolution payload. The GOKTURK-1Satellite was lofted in a Sun-synchronous Polar Low Earth Orbit at an altitude of 689km, circling one complete orbit in 98 minutes, 14 times a day. The service life of GOKTURK-1 is 7 years and the satellite will operate in various imaging modes such as point, strip, wide area and 2-point stereo. While elevation information can be obtained with stereo imaging, the image width will be 15km in point imaging and the strip length will be 780km in strip area imaging.

The GOKTURK-1 Satellite has the capability to collect images in East-West and North-South directions.

USET/AIT (Assembly Integration and Test) Center

One of the most important achievements of the GOKTURK-1 Project is the establishment of the TUSAS Space Systems Assembly Integration and Test Center (AIT), which is one of the major infrastructures in the region. The management responsibility belongs to Turkish Aerospace Industries by the agreement signed between TAI and the SSB. The establishment cost was covered by the Presidency of Defence Industries (40%) and the Ministry of Transport and Infrastructure - Türksat Company. (60%).

The AIT Center, one of Europe's largest and Turkey's biggest satellite test facility, was opened by President Recep Tayyip ERDOĞAN on May 21, 2015, at Turkish Aerospace KahramanKazan/Ankara campus.

The foundation of the AIT Center, of which land and infrastructure needs were met by TAI, was laid on October 29, 2011. The Center includes a 9.800m2 closed area and 3,800m2 100,000-Class Clean Room, mechanical, thermal, acoustic and electromagnetic interaction environments. Qualification tests can be performed as conditions will be created exposing satellites to environments that will mirror launch and in-space conditions. In the Center, which is a critical infrastructure for the in-country production of future observation and communication satellites, the assembly, integration and test activities of multiple satellites, up to five tons, can be carried out at the same time and all these activities will be conducted by the expert and trained technical teams of Turkish Aerospace Industries.

Officially accepted in 2017, the AIT Center took part in the conformance and functional tests in accordance with the environmental conditions that the GOKTURK-1 Satellite will encounter in space. The AIT Center consists of a Thermal Vacuum Chamber, Compact Antenna Test Chamber, Acoustic Room, Section for EMC/EMI Electromagnetic Compatibility Tests, Sections with mass and center of mass measurement instruments, vibration system, solar array deployment test and sections where insulation blankets protecting the satellite are manufactured.

TUSAS Space Systems Assembly Integration and Test Center

GOKTURK-II Satellite

The GOKTURK-2 Satellite, which was developed in order to meet the 2.5m resolution satellite image requirements, with an 80% domestic contribution in terms of engineering and 40% in parts/ hardware, was indigenously designed by TUBITAK Space Technologies Research Institute (%51) and Turkish Aerospace Inc. (%49).

The satellite hosts a payload developed by Satrec Initiative (SI) of South Korea, collecting images in Panchromatic at a 2.5m resolution and 4-band Multispectral at a 5m resolution, and additionally a Near Infrared (NIR) Satellite Camera named KUZGUN, domestically developed by TUBITAK Space Technologies Research Institute, with a 20m SWIR (Short Wave Infrared) resolution.

The GOKTURK-2 Satellite, which is controlled from Satellite Ground Station in Ahlatlibel, started to serve the TurAF in a fully operational capacity in April 2013, collecting images from any part of the world without restrictions.

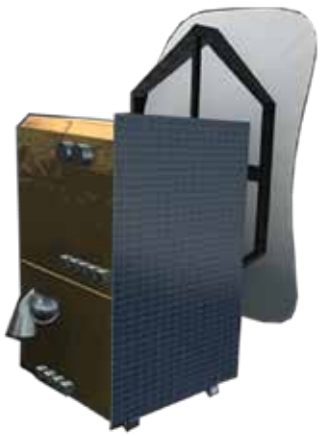
The GOKTURK-2 measuring 1.9m x 1.9m x 1.9m is set at a sun-synchronous orbit at a distance of 686 kilometers from the ground and completes one orbit (the satellite passes from the southernmost to the northernmost point of Turkey in 80 seconds) around the earth every 98 minutes. The GOKTURK-2 Satellite contains high-speed data communication capabilities and can download an image strip of approximately 640km in one pass. It has a dry mass of approximately 409kg and a wet mass of 450kg. The GOKTURK-2 cycles around the earth from the poles 14/15 times a day and makes contact with the Ground Station day and night for 40 minutes each contact and has an average revisit time of 2.5 days.

The GOKTURK-2 National Reconnaissance and Surveillance Satellite is under the command & control of the TurAF and has been operating in orbit for about the last seven years. The satellite has a design life of five years and completed its fifth year in orbit on on December 18, 2017 and it has been successfully continuing its mission as of July 2019.

GOKTURK-II EO Reconnaissance and Surveillance Satellite Technical Specifications	
Orbit	686km circular, sun synchronous
Life Span	5 years
Weight	409kg
Image Resolution	PAN 2.5m, MS 5m
Maximum Image Strip Length	640km
Image Frame Size	20km x 20km
Revisit Time	Avg. 2.5 days, max 5 days
Image Storage Capacity	45 frames (with lossless compression)
Pointing Accuracy	<1km
Geolocation Accuracy	<1km
Wide Area Image Size	100km x 34km
Stereo Image Size	100km x 20km
Image Download Rate	100Mbit/s

Aperture Radar (SAR) Satellite System

The GOKTURK-3 Project, which aims to develop space-based imaging capability in any weather condition, day and night,



by means of tan Synthetic Aperture Radar (SAR) sensor, consists of the domestic procurement of a high-resolution SAR Reconnaissance and Surveillance Satellite and mobile and fixed ground stations.

In January 2013 at the Defence Industry Executive Committee (SSİK/DIEC) Meeting; it was decided to initiate contract negotiations with Turkish Aerospace Industries for the development of the GOKTURK-3 Satellite Project, which will have SAR imaging capability, with the support of TUBITAK Space Technologies Research Institute and Aselsan and as a result of the intensive studies carried out in this direction, the contract negotiations were completed and the GOKTURK-3 SAR Satellite System Development Project Pre-Design Agreement (Phase 1)

was signed between the SSB and Turkish Aerospace Industries in May of 2013 during IDEF 13. Phase 1 of the project was completed in May 2016. Currently, studies are being carried out for the detailed design, manufacturing, testing, launching and in-orbit delivery of the GOKTURK-III (Phase I) Satellite as part of Phase 1, and Phase II of the Project will cover the insurance processes of satellite and the launching and development of the ground segment. Following the signing of the contract, it is expected that the GOKTURK-III Satellite test and launch calendar will be clarified.

The GOKTURK-III SAR Satellite, equipped with an AESA antenna, is planned to be launched into space in 2019 and to be placed in a Sun-synchronous orbit at an altitude around 500km. The Aselsan Radar Systems Roadmap date indicated a date after 2020 for the GOKTURK-III SAR Satellite. The GOKTURK-III Satellite is expected to be sent into space in 2021.

GOKTURK Replacement Satellites

Within the scope of the GOKTURK Replacement Satellites Project that launched with the decision taken at the DIEC Meeting on May 6, 2014, the SSB was authorized to start contract negotiations with TUSAS for the Pre-Design Phase. According to the information we have obtained, the project includes the production of satellites for reconnaissance and surveillance, which will continue as GOKTURK-4/5/6...

In this context, the GOKTURK-IV EO Reconnaissance & Surveillance Satellite, which will replace the GOKTURK-I EO Satellite, will be manufactured at the AIT Center at TUSAS facilities. The GOKTURK-IV Satellite will be designed and manufactured with domestic resources and capabilities and will be equipped with a sub-meter resolution EO camera and is planned to be launched into space a year before the GOKTURK-I Satellite completes its mission in orbit, so that the two satellites can operate together for a year. Subsequently, the following replacement satellite after the GOKTURK Replacement Satellite will also follow suit in this way.

IMECE Sub-Systems Project

IMECE Sub-Systems Project, which aims to develop sub-systems for High-Resolution Earth Observation Satellites in our country and to create the necessary R&D integration and test infrastructures for this purpose, was initiated under the coordination of the Ministry of National Defence (MSB) Department of R&D and Technology (the MSB and the SSB R&D Departments merged under the SSB Department of R&D and Technology Management) and the duration of the signed contract was announced as December 27, 2013 - January 2019.

Earth Observation Satellite Development (IMECE) Project

The IMECE Project Agreement, which was funded by the TUBITAK 1007 Program, was signed on December 21, 2016 between the SSB, TUBITAK, and the TUBITAK Space Technologies Research Institute. The project aims to ensure the continuity of the skills acquired with the GOKTURK Projects in the domestic space/satellite field, to provide space qualification for the indigenously designed satellite systems and subsystems to be developed and to reduce the dependency on international markets.

The IMECE Satellite, to be designed and manufactured entirely by Turkish technicians and engineers and sent into space in 2021, will be inserted into a Sun-Synchronous orbit at an altitude of 680km and will collect Panchromatic images at a 90cm resolution and full color images at a 3.6-meter resolution. The satellite is intended to have high-speed data communication (DC) and will be capable of downloading approximately a 1,000km image strip in a single pass.

The high-resolution EO Satellite Camera, which is currently being developed by TUBITAK Space Optical Systems Research Laboratory (OPMER) for the high-resolution IMECE Satellite. The High Definition Satellite Camera features a diffraction limited Korsch type optical/telescope architecture. The national EO satellite camera is equipped with CMOS TDI image sensors. With the TDI feature, the image of a point on the earth can be collected from multiple pixels which increases the signal/noise ratio of the image. Since the satellite's orbital speed of ~ 7.5 km/s does not provide sufficient exposure time, TDI is required for high-resolution satellite cameras. The CMOS TDI sensor being developed is expected to be an alternative to the commonly used CCD TDI technology in observation satellites.

TUBITAK Space Technologies Research Institute is carrying out the design, analysis, manufacturing, and testing of the IMECE Satellite and all sub-systems including the onboard computer and power supply of the satellite, within the country. The Turkish Aerospace AIT Center is supposed to be used for satellite environmental tests.

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THE SKIES AND BEYOND

The Solar Panels developed by the TUBITAK Marmara Research Center (MAM) and the Lithium-Ion batteries to be developed by TUBITAK Energy Institute for the first time in Turkey, will become space-qualified on the IMECE satellite and therefore foreign dependency will be eliminated.

A highly efficient Space Qualified Solar Cell developed by Gazi University will be used in the Solar Panel to be used as the experimental payload of the IMECE satellite. The Particle Radiation Test Infrastructure to be established by Middle East Technical University will be one of the important infrastructures meeting the test requirements for developing space qualified materials. The Sub-systems to be developed within the scope of IMECE Sub-System Projects will be designed to meet future satellite needs. Therefore, Turkey will take its place among the few countries producing technology in space with national resources. Although, the IMECE Satellite was planned to be launched into space and become operational in 2020, a delay in this schedule is expected.

TAF Satellite Communication System (TUMSIS) Project and National Military Satellite Communication System (MAHU/TURKSAT-6M)

In addition to the reconnaissance and surveillance satellites, the TAF also makes use of the TURKSAT series dual-use communication satellites. The Turkish Armed Forces X-Band Satellite Communication System using electronic warfare (EW) protected X-Band transponders belong to the TAF on TURKSAT-4A Satellite.

According to the MSB 2017 Annual Report, X-Band transponders are planned to be installed on the TURKSAT-5B Satellite and the TURKSAT-6A Satellite. However, according to the press release issued after the signing ceremony of the satellites to be produced by Airbus Defence & Space (ADS) on November 9, 2017, the TURKSAT-5B weighs in at 4,500kg and is scheduled to be placed in its orbit in 2021, will be a broadband satellite operating in Ku and Ka-bands. Among the communication satellites currently operational, the TURKSAT-3A hosts Ku-Band, the TURKSAT-4A hosts X-Band and Ka-Band, and the TURKSAT-4B hosts C-Band, Ku-Band and Ka-Band transponders. New communication satellites to be placed in orbit in 2020, the TURKSAT-5A weighing 3.500kg will host Ku-Band, TURKSAT-5B will host X-Band, Ku-Band and Ka-Band, and the TURKSAT-6A will host X-Band and Ku-Band transponders. The design and production activities of the TURKSAT-5A and the TURKSAT-5B satellites are currently underway at ADS facilities in France and England, in accordance with the schedule and the Critical Design Review Phase of both satellites has been completed.

TURKSAT 6A Satellite on the Turkish Aerospace Facilities

The increasing military communication needs of the TAF will be met through both the TURKSAT-6A Satellite and the National Military Communication Satellite, which will be designed and manufactured with national resources and will include X/UHF/Ka-Band transponders. Indigenous products have been developed for the mission payload of the satellite, and these products will also be used in military communication payloads. For the satellite platform and other subsystems, the plan is to use the expertise acquired within the scope of the TURKSAT-6A. In this context, for example, Turkish Aerospace plans to use the satellite platform developed in the TURKSAT-6A Project for the next military communication satellites and conducts its studies in this direction.

The contract of the TSK X-Band Satellite Communication System was signed with Aselsan in December 2013, and it is an IP based system to be operated in accordance with today's conditions. The system covers both space and ground segments. Studies related to the space segment are being conducted according to the calendar of the TURKSAT-6A Satellite, which will host the mission payload, and the delivery activities as part of the work on the ground segment which are scheduled to start in 2020. Within the scope of the Project consisting of indigenous units nationally developed by local sub-contractors, there are ground stations on various platforms including main and backup control centers for the command & control of the stations.

According to the Aselsan 2017 Annual Report; Aselsan is responsible for the design, manufacturing, functional and environmental testing, transportation to the platform manufacturer, providing technical support for satellite integration activities to be performed by the platform manufacturer, and conducting the in-orbit tests of one X-Band Satellite Communications Mission Payload by utilizing national resources and infrastructure, in order to meet the TAF Satellite Communication requirements. The design activities of the Frequency Down-Convertor (DOCON), Channel Amplifier (CAMP) and Harmonic Filter instruments, are being developed and tested by the company and continue in 2019.

Space segment requirements

TURKSAT-6A Communication Satellite

Orbit	42° East
Payload	20 Ku-Band Transmitter
Life Span	> 15 years
Dry Weight	~1.700kg
Total Weight	~4.200kg
Power Generation	~7kW (End-of-life)
Launch Date	2021

of the TAF Ku-Band Satellite Communication System Project, which was initiated to provide voice, fax and data communication services to TAF units, which are not connected by TAFICS and Turk Telekom Inc. infrastructure, are met by band leasing through the TURKSAT-3A and the TURKSAT-4B Satellites. Within the scope of the project, for the ground segment there are various type of portable and ship satellite terminals, including main and backup control centers for the command & control of the stations. The deliveries of satellite terminals and the satellite communication control centers, which provide a secure communication infrastructure for the TAF, have been completed and commissioned by the TAF.

TURKSAT-6A National Communication Satellite

The TURKSAT-6A National Communication Satellite will have Ku-Band and X-Band transponders. The TURKSAT-6A National Communication Satellite, with completely national software and design, will be able to perform both commercial and military tasks. The contract for the development and manufacturing of Turkey's first domestic/national communication satellite TURKSAT-6A was signed on December 15, 2014. Assembly, integration and test activities of the TURKSAT-6A Satellite are being carried out at the Turkish Aerospace AIT Center and the service life of the satellite is estimated to be a minimum of 15 years. The TURKSAT-6A, the first communication satellite of our country which was planned to be ready for launch in December 2020 (and later updated as 2021), is being developed with the partnership model established in accordance with the qualifications of TUBITAK Space, Turkish Aerospace, Aselsan, and CTECH Companies. A total of 342 personnel work on the project under a 72-month schedule.

Aselsan is developing the Ku-Band (commercial/military) and the X-Band (military) communication payload of the satellite, the company also uses composite materials and CFRP/CRP technology to manufacture the shaped reflector antenna (for more efficient power management) of the TURKSAT-6A Satellite, which will provide coverage for Turkey entirely.

The production of the TURKSAT-6A, with a weight of approximately 4,200kg including propellant and a nationally designed and manufactured electric propulsion system, was started with the Project Initiation Meeting that was held on January 29, 2015. The assembly of the Structural-Thermal Qualification Model (STM) of which the durability and the structural systems tested was scheduled to start in December 2017, while testing of the STM was scheduled to start in April 2018. Additionally, the assembly of the Flight Model, which will perform missions in orbit was scheduled to start in 2018. According to the data of the Ministry of Transport and Infrastructure, 41% of the TURKSAT-6A Project as of November 2017 and 47% as of April 2018 have been completed.

The studies on the TURKSAT-6A National Communication Satellite, which are expected to be completed within 60 months, are currently underway. The satellite is planned to be placed into an orbit of (Geosynchronous Equatorial Orbit) 42° East in 2021. Within the scope of the project, three different satellite models (Engineering, Structural-Thermal Qualification, and Electrical/Electronic Satellite) will be produced and the fourth satellite model (Flight Model) will be sent into space. Therefore, under the TURKSAT-6A National Communication Satellite Project, four different satellite models will be produced. With the TURKSAT-6A Project Turkey will launch a national satellite into GEO (36.000km) for the first time. The propulsion system developed from the HALE project will be used in the TURKSAT-6A.

National Ground Station Development Project (MIYEG)

The opening meeting of the National Ground Station Development Project (MIYEG) to be realized by TUBITAK Space Technologies Research Institute to develop and provide a national ground station for earth observation satellites which is planned to be launched in the coming years, was held at TUBITAK Space Conference Hall on February 18, 2015. Within the framework of the MIYEG Project to be realized by TUBITAK Space Technologies Research Institute with the coordination of the SSB Department of Air Defence and Space and the incentive of the Ministry of Development, a national Ground Station System capable of communicating in X and S-Bands will be developed. The project is expected to be completed in 2019.

TURKSAT- 6A

Turkish Aerospace and Small-GEO Communication Satellite

Turkish Aerospace has started feasibility studies for the New Generation Communication Satellite Project, which is called Small-GEO in international terminology. The company aims to offer new-generation communication satellites on the global market through the Small-GEO Project, which will be realized with the experiences obtained from the TURKSAT-6A communication and the GOKTURK earth observation satellites.

Turkish Aerospace aims to accomplish an important project in the field of space systems with a high added value by developing the Small-GEO concept which can meet the needs of domestic and international satellite operators. With the activities to be carried out within the Small-GEO Satellite concept, satellite subsystems will be fully optimized in order to reduce the launch costs by fitting multiple communication satellites into a launch vehicle. Another measure to reduce launch costs would be to equip the satellite with a new generation of electric propulsion systems to reduce the mass sent into space.

The details of Small-GEO Satellite will be determined with the studies to be completed and it is planned to have a weight range of 1 to 2 tons and carry 16 to 24 transponders. The Small-GEO satellite, which will be developed by Turkish Aerospace and equipped with an electric propulsion system, can also be used for military data transfer in addition to civil communication services.

The Small-GEO Satellite is a cost-effective communication satellite concept with a relatively narrow volume configuration, which can meet conventional communication satellite functions such as television broadcast, multimedia applications, mobile and fixed internet access, and secure communication without performance degradation. Small-GEO satellites stand out with their low production and launch costs and high-performance broadcast and communication solutions compared to conventional communication satellites.

ASELSAT Cube Sat Development Project

ASELSAN initiated the ASELSAT 3U Cube Sat Development Project to earn flight heritage for Aselsan's indigenously developed miniaturized X-Band Transmitter. Aselsan designed X-Band Transmitter will send the optical data, which will be created by ASELSAT's camera payload (able to be taking pictures at 30m GSD), to the ground station. Also, its secondary payload radiation dosimeters will collect statistical data from the low orbit space for design activities. The main mission of the ASELSAT satellite is to take images and transmit it to a ground station via X-Band Transmitter. Within the scope of the Project the PDR phase was completed in 2018, and as of May 2019, the production and assembly of the ASELSAT 3U Cube Sat Flight Model is ongoing. In February 2019, Aselsan received permission from the Information and Communication Technologies Authority to test the ASELSAT 3U Cube Sat. The ASELSAT 3U Cube Satellite is scheduled to be placed into its orbit in 2019.

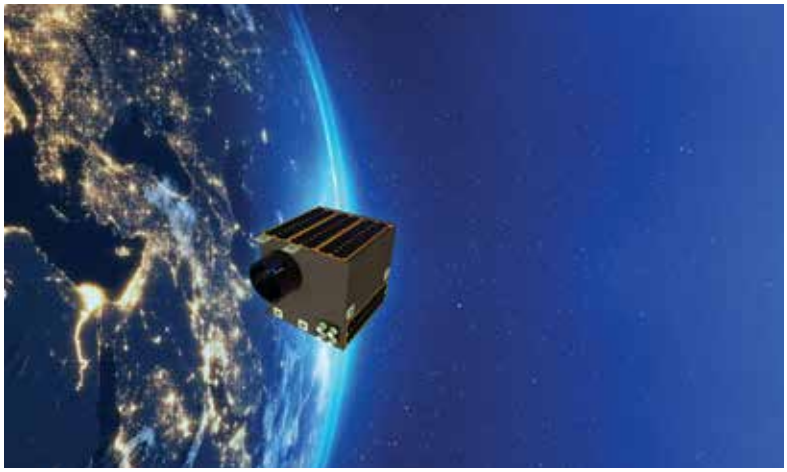
Under the ASELSAT 3U Cube Sat Development Project, Istanbul Technical University (ITU) Department of Aerospace Engineering and Atılım University Department of Mechatronics Engineering are working as sub-contractors. The preliminary design phase for the cube satellite platform was developed by ITU Aerospace Engineering team has been completed and the critical design phase studies are in progress. The Critical Design Phase of the Indigenous Reaction Wheel, developed by Atılım University, continues in accordance with the project management plan.

STM Small Satellites LAGARI and PIRISAT

STM, one of the leading companies in the defence industry, exhibited Turkey's first high-resolution Earth observation micro-class satellite "LAGARI" at the IDEF '17 Fair. The LAGARI Satellite will conduct reconnaissance and surveillance missions such as providing tactical images of the field, general mapping, forest & vegetation monitoring and natural disaster monitoring.

The new version of LAGARI, equipped with the selected camera system solution, was displayed at the STM stand during the 3rd Global SatShow, held on November 9-10, 2017. The LAGARI has a new generation high-resolution (PAN <2m, MS <8m resolution) electro-optical (EO) camera with the ability to acquire PAN and multispectral spot/strip images, and it is the first national investment to provide satellite imagery as a complementary system for Turkish space technology. STM has been awarded with "Distruptive Innovator of the Year Award" in the 3rd Global SatShow event.

The satellite, named after Lagari Hasan ÇELEBİ, who is considered to be the first person to perform rocket-powered space flight by many respected institutions and organizations working in the



LAGARI New Generation Micro-Earth Observation Satellite

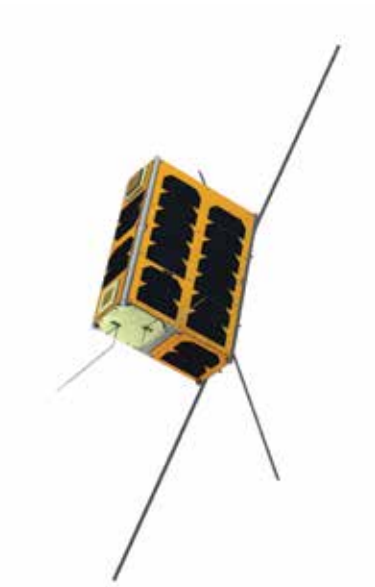
space field, is scheduled to be sent into space in 2020. The LAGARI, weighing 70 kg in the Micro-Satellite category, will be one of the few micro satellites in the world to provide images with the target resolution. Within the scope of the LAGARI New Generation Micro-Earth Observation Satellite Project, a Sub-Contractor agreement was signed with Berlin Space Technologies GmbH and a Launch Service agreement was signed with Antrix Corporation Limited for the satellite to be launched with India's PSLV rocket. As of May 2019, the EO camera and sub-system manufacturing activities are ongoing.

STM, in addition to the LAGARI New Generation Micro-Earth Observation Satellite Project, also carries out other projects for space systems and applications such as the PIRISAT Nano Satellite Platform for Automatic Identification System Application Project, Satellite Constellation Mission Optimization Tool Development Project and Resolution Enhancement Algorithm Development Project for Electro-Optical Satellite Images.

STM launched the PIRISAT concept in the nanosatellite class, with a size of 6U cubesat (10cm x 20cm x 35cm), during the 3rd Global SatShow on November 9-10, 2017. The main objective of the project is to demonstrate space-based Automatic Identification System application on a Nano satellite platform developed by STM. Ships equipped with AIS receiver, which is a secure means of communication, can transmit detailed information such as ID, call codes, coordinates, route, speed, size, destination port and estimated time of arrival. In this way, it is aimed to provide safer navigation for ships and to allow maritime authorities to monitor marine traffic more accurately.

Another important feature of the PIRISAT is that various electronic components and experimental products to be developed by universities and SMEs will be integrated in the satellite to provide space-qualification to newly developed equipment's and products. Thus, it will contribute to the development of national space technology.

PIRISAT will have a maximum weight of 10kg which is the limit for 6U cubesat standard and will have the capability to carry 4kg of payload. The satellite is planned to be sent into space in 2020.



Turkey Space Agency Established

Turkey's official gazette published a Presidential Decree (number 23) on Thursday, December 13, 2018 announcing the establishment of the country's space agency. The Presidential Decree was signed by the Republic of Turkey's President Recep Tayyip ERDOĞAN on December 12, 2018.

The Turkey Space Agency (TUA) will report to the Turkish Ministry of Industry and Technology but will coordinate and cooperate with other government ministries and agencies as required in the fulfillment of its mission. The Agency has a mandate from President ERDOĞAN to organize, coordinate, and manage all Turkish space activities, to include research and development, advocacy and education, and international cooperation and representation. The Agency is also charged with ensuring that all national and international laws applying to space are enforced and implemented.

The TUA will prepare and carry out the National Space Program in line with the policies determined by the President of Turkey, according to the decree.

The Agency will have financial and administrative autonomy as well as a special budget and will pave the way for the establishment of a competitive indigenous industry. The agency will also pursue multilateral and bilateral cooperation with its international counterparts while protecting Turkey's rights at the United Nations.

One strategic purpose of the TUA is to, "reduce external dependence in space and aviation science and technologies, to increase the competitiveness in the international arena, to create scientific and technological infrastructure and to develop new technology."

"We are forming the Turkish Space Agency in order to strengthen our aerospace industry, improve scientific infrastructure and human resources in the field of space technology and further boost our capacities and abilities," a Turkish Government spokesperson said.

The TUA will be headquartered in Turkey's capital city, Ankara

The Last A400M for the TurAF Will Be Delivered in 2022!

Defence Turkey talked to Mr. José Luis de Miguel CORTÉS, Airbus Defence and Space Vice President & Head of Product Marketing on the status of the A400M Program and the deliveries to Turkish Air Force (TurAF)

Defence Turkey: How would you best describe the current status of the A400M Program, which was initially considered as Airbus' strategic move into the military transport aircraft sector but in time has turned into a headache due to industrial problems that hampered the program and caused the company to pay heavy penalties for both the capability shortfalls and the delays to resolve them? Have you resolved the industrial problems including the flaw discovered in the propeller driving power gearbox of the TP400-D6 engine?

José Luis de Miguel CORTÉS: On June 14th we announced the Global Re-baselining of the Program. We are extremely grateful to the Customer Nations and OCCAR for their continued support and the constructive discussions on this complex subject matter, achieving a decisive de-risk of the A400M Program that will ensure its present and future as the air forces backbone for strategic airlift for the decades to come.

Despite the past industrial issues suffered on the A400M the situation has significantly changed in the last years. On the industrial side, we have been able to stabilize production delivering what we promised to our customers. It is of great importance to say that our flight test campaigns are giving excellent results, and with regards capabilities the A400M is being a game changer for our customer. With 81 aircraft in service, our customer nations are deploying the aircraft all over the world on many different missions, and that is a huge satisfaction for us.

Defence Turkey: Could you please comment on the major contractual milestones achieved so far under the A400M Program? How many A400Ms have been manufactured so far and how many of them were handed over? How many flight hours have been accumulated with the delivered A400Ms?

José Luis de Miguel CORTÉS: Until now we have delivered 81 aircraft to six nations and in 2020, we will deliver the first aircraft to Belgium and Luxembourg. With regards flight hours, the global fleet has already achieved more than 53,000 FH.

TuRAF's 1st A400M

Defence Turkey: Total firm orders for the A400M still stand at 174 aircraft and despite the aircraft's uncontested capabilities, no additional order has been booked so far. Fernando ALONSO, Head of Airbus Military Aircraft, said in July 2018 that six firm offers had been submitted to prospective customers, two of which were under negotiation at the time, and one of which he hoped to conclude by the end of the year. When do you expect to conclude your negotiations with potential export customers and to announce first export order (after Malaysia) for the A400M?

José Luis de Miguel CORTÉS: The recent signature of the new agreement with our customer nations has settled the A400M towards a much clearer scenario for finalizing the capability development and at the same allowing more time for export sales.

These elements are the foundation for the next phase of the A400M Program, which is to complement the Launch Nations aircraft with export sales.

The capabilities that the A400M will provide on the export market will put the Air Forces ahead of the rest and will enable them to perform any kind of tactical or logistic mission they might need, as well as other more specific missions such as Air to Air Refueling.

At this moment we are in dialogue indeed with various prospective customers but will not give details with regards to the specific status.

Defence Turkey: Are there any military transport aircraft currently available that can match the A400M? Do you think Embraer's KC-390's will become a strong competitor for the A400M in the military airlift market during next 5 to 10 years?

José Luis de Miguel CORTÉS: I don't see a real threat as the

Aerial refuelling to F-35 JSF from A330 MRTT

A400M and the KC-390 are different aircraft. The A400M is unique on the market, because it's the only aircraft able to cover all current and future needs for heavy strategic as well as tactical transport.

The A400M, thanks to its 37t payload and 4x4m cross-section, is able to transport the heavy and outsize loads (such as helicopters, cranes or excavators) that are too heavy or too big for legacy and future tactical aircraft.

At the same time, its long range and high-speed cruise capability allows to reach destinations at long distances and, as fast as turbofan strategic aircraft.

But also, thanks to its turboprop engines, it retains the capability of operating from short and soft unpaved airstrips as legacy tactical aircraft; and it can be quickly reconfigured for air-to-air refueling missions, to give fuel to fast and slow receivers at their required altitude and speed.

Defence Turkey: The footprint of ADS in Turkey spans several decades of success, which started with the CN235-100M military transport aircraft of the Turkish Air Force (TurAF). Turkey is one of 8 original partner nations and the TurAF, which has 10 A400Ms on order, today enjoys a total of 7 A400Ms that make up a very important Strategic Air Lift capability for the country. Aircraft number 8 and number 9 are both expected to be delivered in the 2019 summer timeframe. Can you elaborate on the current status of TurAF's 8th and 9th A400Ms, when do you expect to deliver them to TurAF? Can you elaborate on their configuration level? Batch 4 or Batch 5?

José Luis de Miguel CORTÉS: The 8th aircraft for the Turkish Air Force has been already delivered to the customer at our facilities in Seville, Spain, with a second aircraft also close to delivery.

With regards configuration, the 8th aircraft has been delivered with the latest standard, including tactical capabilities.

Defence Turkey: Can you elaborate on the delivery year of TurAF's 10th and last A400M? Can you elaborate on the configuration level of this last A400M?

A400M is landing unpaved runway

José Luis de Miguel CORTÉS: The last A400M for the Turkish Air Force will be delivered in 2022.

Defence Turkey: How many flight hours have been accumulated with TurAF A400M fleet since the first flight in April 2014?

José Luis de Miguel CORTÉS: Approximately 4,000 flight hours done in total performing all types of missions including personnel and cargo transfer.

Defence Turkey: Can you elaborate on the availability rates of the TurAF A400Ms?

José Luis de Miguel CORTÉS: We should not give exact operative details that concern one of our customers, but we can state that the Turkish Air Force A400M fleet availability rates are among the highest of the A400M user nations.

Defence Turkey: Considering the fact that the ageing C-160D Transall Aircraft would be put out of service from 2020 onwards, the TurAF is expected to order additional A400Ms or other transports aircraft in similar classes (i.e. AN-188) in order to fulfill the transport aircraft requirement that would emerge for the year 2020 and afterwards. Have you received any formal interest from Turkey to place an order for further A400Ms so far?

José Luis de Miguel CORTÉS: We can't comment on behalf of our customers but considering the outstanding capabilities of the A400M and its ability to conduct a wide array of missions it would always be a good choice to further enlarge the A400M fleet.

Ayşe EVERS, Editor in Chief of Defence Turkey Magazine met with José Luis de Miguel CORTÉS, Airbus Defence and Space Vice President & Head of Product Marketing

Defence Turkey: The combat-proven A330 MRTT has been ordered by 12 nations which have now placed firm orders for 60 aircraft, of which 35 have been delivered. Entered service in 1995 the KC-135R Stratotanker fleet of the TurAF is going out of date day by day and metal fatigue is seen on some aircraft. Thus, the TurAF is planning to replace them with a new generation tanker aircraft (A330 MRTT and KC-46A Pegasus). Have you performed any discussion or delivered any briefing to the TurAF and/or SSB on A330 MRTT so far?

José Luis de Miguel CORTÉS: Being the benchmark in the global market, obviously we think the A330 MRTT could also be a perfect asset for the Turkish Air Force. The aircraft represents a huge leap from previous generation tankers, and provides more fuel, more cargo and more passenger transport capabilities than any other competitor. In addition to the pure Air to Air refueling, as part of our Smart MRTT approach we are further expanding the A330 MRTT capabilities towards enhancing connectivity and addressing new roles such as C2 and ISR, that could be also of strong interest.

Defence Turkey: What can you tell us about the current status of Liaison & Utility Aircraft Project, covering the supply of 9 Liaison and General-Purpose Aircraft (GMU/GPA), 6 for the Turkish Land Forces and 3 for the Turkish Police. As one of the bidders of this tender ADS has offered its C295 aircraft to meet this requirement? When did you submit your proposal under the Liaison & Utility Aircraft Project and when do you expect announcement of the winner?

José Luis de Miguel CORTÉS: As said before we don't disclose detailed information on specific prospects, but the C295 through its versatility and flexibility could indeed be a great asset for the various Turkish services, also having in mind the already available experience with the CN235 and the delta capabilities the C295 provides.

Defence Turkey: Mr. CORTÉS thank you for sparing your time for our readers?

Airbus and OCCAR Sign New A400M Global Support Contract


© Airbus

On 1 July 2019 Airbus and the Organization for Joint Armament Co-operation (OCCAR) announced that they had signed a new Global Support Step 2 Contract for the A400M transport aircraft, replacing a previous agreement from 2016. Airbus is the Prime Contractor of the A400M Program and OCCAR manages the multinational A400M Program on behalf of the Launch Customer Nations Germany, France, United Kingdom, Spain, Turkey, Belgium and Luxembourg.

The announcement of a new global support contract for the A400M comes two weeks after Airbus and OCCAR announced that they had signed an amended A400M development and production program contract.

The A400M Global Support Step 2 Contract includes all of the launch nations of Belgium, France, Germany, Luxembourg, Spain, Turkey, and the UK, replacing the Step 1 contract, which signed in 2016 and only covered France, Spain, and the UK.

The contract will bring the benefits of a fully integrated suite of common services using shared resources and assets. It provides a full range of tailored services to meet the needs of the A400M customers, from ground support to airworthiness and from maintenance to material support.

This performance-based contract creates a new partnership framework, based on pooling and sharing, where industry and operators have the opportunity to explore new areas of collaboration, concepts and services. The modular structure of the services allows for the tailoring of solutions as per specific operational requirements.

The pooling and sharing under Airbus management will allow the A400M customers to benefit from significant savings while keeping the same highest standard of services.

This new phase of the A400M Global Support Contract provides a support services package to a wider number of nations operating the A400M until the end of 2023. After France, UK and Spain, which were part of the first phase, now Turkey, Germany, Belgium and Luxembourg have joined as well.

Alberto GUTIÉRREZ, Head of Military Aircraft at Airbus Defence and Space, said: "With this services contract, we are working together with our customers on innovative solutions never performed before on a military program. After the agreement with the launch customer nations on the program's contract amendment this is another clear signal that through mutual collaboration, we are strengthening the future of the A400M."

Gary PALMER, OCCAR A400M Program Manager, said: "The A400M Global Support Contract covers more than 40 individual services working together, a complete pool of services from ground support to airworthiness, through to maintenance or material services. Under this collaborative model, the more nations that join the pool, the more efficient the services become from which customers can benefit"

by İbrahim SÜNNETÇİ

A Look at the TurAF's Ongoing Fixed Wing Jet Powered Air Platform Programs

As one of the largest air forces in the world, the Turkish Air Force (TurAF) currently has around 750 pilots (as of February 2019) as well as 270 combat aircraft including 238 F-16C/D (35 x Block 30M, 1 x Block 30TM ÖZGÜR, 102 x Block 40M, 71 x Block 50M and 29 x Blok 50+) and some 30 F-4E 2020s, 180 trainers (including 68 T-38M jet trainers, 16 NF-5A/B 2000s [10 NF-5A 2000s and 6 NF-5B 2000s] in the Turkish Stars Acroteam inventory, 40 KT-1Ts, around 30 SF-260Ds and around 25 T-41Ds), and around 100 Transport/Support aircraft (including 8 A400M [+2 to be delivered], 4E-7T AEW&C aircraft, 19 C-130B/E Hercules [6 B and 13 E, undergoing avionics upgrades under the ERCİYES Project], some 10 C-160Ds [5 in transport, 3 in GÖREN ISR configuration and 2 in MilKar-2U Electronic Warfare configuration], 49 CN235-100M [45 in Transport/Air Ambulance/ Training role, 3 in SIGINT/ELINT configuration and 1 in Open Skies Agreement (ASA) configuration], 7 KC-135R Stratotankers) in its inventory.

The TurAF's 238 F-16C/D fighters are currently operated by 10 different Squadrons deployed at 7 different bases (Eskisehir 1st MJB, Konya 3rd MJB, Merzifon 5th

MJB, Bandırma 6th MJB, Diyarbakır 8th MJB, Balıkesir 9th MJB and İncirlik (Adana) 10th MJB) around Turkey. Most of them have been modernized to the latest Block 50+ standards under the PO-III and F-16 MSM/CCIP Programs. There are also some 30 upgraded F-4E 2020 Phantom II all-weather fighter-bombers (in 111th Squadron service located in 1st MJB, but F-4E 2020s are deployed both in 1st MJB and 7th MJB under the 111th Squadron umbrella and are planned to be replaced by F-35As). Turkey, as a Level-III Partner in the F-35 Joint Strike Fighter (JSF) Program, has a plan to procure as many as 116 F-35A aircraft, which will provide the TurAF with 5th Generation stealth and long-range strike capability. The T-41Ds are used for Screening Flights, while the SF-260Ds are used for Primary Flight Training. T-41Ds and SF-260Ds are to be replaced with MFI-17 395 Super Mushshak Primary Trainer Aircraft produced by Pakistan. The T-38M Advanced Jet Trainer Aircraft will fly until 2030s. New Generation Advanced Jet Trainer (AJT) version of the HürJet, being developed by TUSAS, is to replace T-38Ms. As a modern, cutting edge air force, configured and trained to the highest Western/NATO standards, the TurAF is able to execute the full spectrum of air missions.

F-35A Lightning II JSF Program

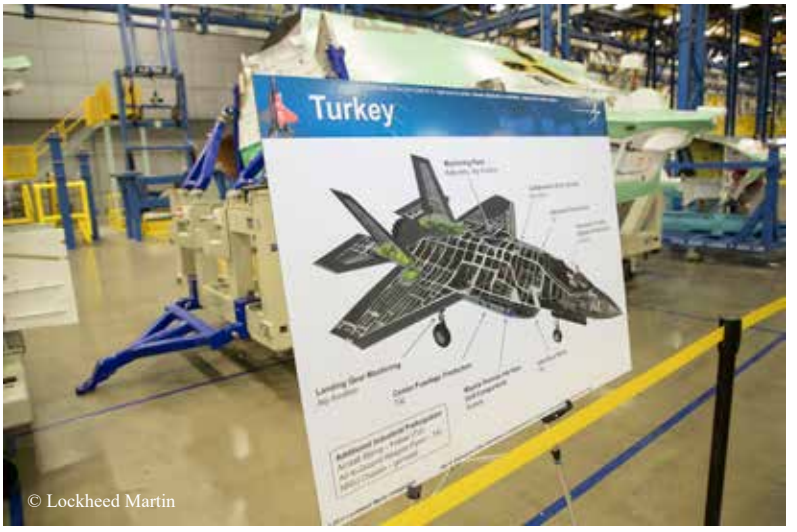
The F-35A was selected as the New Generation Fighter Jet of the Turkish Air Forces Command upon the Decree of the Defence Industry Executive Committee (DIEC) dated December 12, 2006 and the Letter of Intent (LoI) and the Industry Participation Plan was signed between the SSB and the Prime Contractor Lockheed Martin (LM) on February 6, 2007 in Ankara. Turkey has a plan to procure as many as 116 F-35As, conventional takeoff and landing (CTOL) variant, until 2031 for the TurAF to replace the aging F-4Es (already phased out of service but when the project was launched they were in service), F-4E 2020s (which was planned to be phased out of service in 2020 but this deadline was extended in 2018) and F-16C/D Block 30 and Block 40s.

F-35As AT-01 (serial number 18-0001)

Combining new developments such as composite materials, stealth technology, advanced radar, fully integrated avionics and sensors, low observability (including the use of internal weapons bays), have vastly improved situational awareness through a network-centric combat environment and the design ability to act as an integrated data node, the 5th Generation F-35A Lightning II combat aircraft will be a key factor in deterring any attack on Turkey. The F-35A is a lot more than simply an F-4E 2020 and F-16C/D replacement. It will add a wide range of capabilities to the Turkish Armed Forces that Turkey has never had before. The F-35A Lightning II is not just a new generation fighter. It is a completely new weapons system for the TurAF.

Turkey will pay around US$11 Billion for 100 F-35As, and as a Level-III Partner of the Program has already invested US$1,4 Billion so far in the F-35 Lightning II development phase. The estimated value of revenue to be acquired through the work packages assumed by the Turkish Defence Industry throughout the F-35 JSF Program's total duration was calculated to be US$7.5 Billion by the Presidency of Defence Industries (SSB). Speaking at a televised interview held on 13 June 2018 President of Defence Industries (SSB) İsmail DEMİR Ph.D. underlined that the total value of the contracts awarded to Turkish Defence and Aerospace companies under the F-35 JSF Program has reached US$700 Million.

10 Turkish Defence and Aerospace companies (Alp Aviation, Aselsan/MİKES, AYESAŞ, Fokker Elmo, Havelsan, Kale Aero, Kale Pratt & Whitney Engine Industries, Roketsan, TÜBİTAK-SAGE and Turkish Aerospace) have been supporting the development and production phases of the F-35 fighter jets as part of Turkey's partner role in the JSF Program. Turkish Industry has a significant Industrial Participation role supporting Lockheed Martin and Pratt & Whitney for F-35 aircraft sustainment and F135 turbofan engine production and sustainment.



Turkish Defence and Aerospace companies are responsible for 937 parts used to build the F-35, a little over 400 of them are sole-sourced from Turkish firms.

Turkey has also been given the approval to build/assemble its own F135 engines and was also selected to have the first European Regional F135 Engine depot overhaul capability. Both the engine production and overhaul will take place at the 1st Air Maintenance Factory Directorate (1st AMFD, former 1st ASMC) in Eskisehir.

The TurAF F-35As will be integrated with indigenous weapon systems such as Precision Guidance Kit (HGK), GÖKDOĞAN (Peregrine) short-range AAM, BOZDOĞAN (Merlin) Beyond Visual Range (BVR) AAM, SOM Air Launched Cruise Missile and SOM-J air launched anti-ship missile. HGK series smart ammunition and SOM-J missile integration efforts on the F-35A will be launched within the 2021-2022 timeframe with Block 4.2 software. The first live-drop test of the SOM-J missile from the F-16C was successfully conducted in July 2018. The first live firing test with the SOM-J against a target was planned to be executed in early 2019 but did not take place. In fact, even if it can be useful to carry up to six SOM-J missiles (2 in the internal bays and 4 on the external pylons) an F-35A carrying the SOM-J on the underwing pylons would lose much of its stealthiness. Having a range of 150+nm and carrying a single 350lb blast-fragmentation/ semi-armor-piercing warhead the 1,000lb class SOM-J is an air-to-surface missile designed for use against heavily defended, high value maritime targets and land targets. Roketsan has been cooperating with TÜBİTAK-SAGE and Lockheed Martin Aeronautics, the Prime Contractor of the JSF Program since 2014 for the integration of the SOM-J on the F-35. A business partnership agreement was signed with Lockheed Martin Missiles and Fire Control (LMMFC) for the design, development, production and marketing of the SOM-J Weapon System in 2014 and the contract was signed in 2016. The integration activities of the F-35 are being carried out by LMMFC with the assistance of Roketsan and TÜBİTAK-SAGE, and these activities are scheduled to be completed in 2023.

As of 1 June 2019 Turkey has placed an order for a total of 30 F-35As in two batches and all will be deployed at the 7th Main Jet Base (MJB) located in Akçadağ, Malatya. Deliveries of the TurAF's 30 F-35A Lightining II jets are planned to be completed by 2024 The first batch includes 14 (2+4+8) F-35As and the second batch includes 16 (LRIP-13 and LRIP-14) F-35As. The schedule of the TurAF's 30 F-35A Lightning II aircraft per the LRIP contract is: LRIP-10 2 aircraft (2018), LRIP-11 4 aircraft (2019), LRIP-12 8 aircraft (2020-21), LRIP-13 8 aircraft (2022) and LRIP-14 8 aircraft (2023). The US$115 Billon valued LRIP-11 contract covering 141 F-35s (91 for the U.S, 28 for the international

partners and 22 for FMS clients) was awarded in September 2018, LRIP-11 deliveries will be kicked off in 2019. The agreement lowers the price of the F-35A variant from US$943 Million per unit to US$89.2 Million, reflecting a 54% reduction from the previous lot of the JSF Program. The LRIP-12 contract is expected to be awarded during 2019 summer, while the U.S. scans the globe for alternate suppliers for parts currently being made in Turkey, in the event that the country is removed from the JSF Program unless the Turkish Government will back down from the planned purchase of two S-400 Triumph Air and Missile Defence Systems with four batteries from Russia. A total of 14 countries participate in the F-35 JSF Program, but only one - Turkey - is in danger of being expelled from the program. The tension between Turkey and the rest of NATO has continued to grow during first half of 2019 as the country inches closer to accepting delivery of the first S-400 Triumph battery in July, which the U.S. and NATO have said would force them to exclude Turkey from the F-35 team.

According to Ellen LORD, Undersecretary of Defence for Acquisition and Sustainment at the U.S. Department of Defence (DoD), LM and the U.S. DoD have reached a "handshake agreement" for the company to build 157 Low Rate Initial Production Lot 12 (LRIP-12) F-35s with options for LRIP-13 and LRIP-14, which would include 321 aircraft. LORD said in a statement published on Monday, 10 June 2019 that the US$34 Billion agreement includes the delivery of 478 LRIP F-35s for Lots 12 to Lots 14 in support of U.S. service branches, allies and Foreign Military Sales (FMS) clients. The unit price of the USAF F-35A will fall to less than US$80 Million in Lot-13, one year earlier than planned. By the end of 2022, the F-35 JSF Program is expected to be up to full production capacity of 170 aircraft or more annually. On Monday, 3 June 2019 the U.S. Air Force (USAF) announced that Hill Air Force Base, Utah, had received delivery of the 400th Lockheed Martin F-35 JSF. The USAF also announced that the fleet of 5th Generation F-35 jets have completed 200,000 flight hours. The total includes all test, development, and operational jets, both among U.S. and international aircraft, according to the report. The F-35 Joint Program Office expects delivery of 131 F-35s in 2019 (up 40% from last year [91]) 140 F-35s in 2020 and 160 F-35s in 2021.

The 172nd and the 171st Squadrons of the 7th MJB Command will be the TurAF's first F-35A squadrons. Upon delivery, the first batch of 14 F-35As would be deployed at the F-35A Operational Conversion Unit (OCU) Squadron (172nd Squadron), where the TurAF F-35A pilots receive training from Turkish Instructor Pilots who have completed their training in the U.S. The second batch of 16 F-35As is expected to equip the 171st Squadron.

To accommodate F-35As, the entire infrastructure for air operations at the 7th MJB is being restructured under a contract valued at TL429,5 Million (around US$121,6 Million according to the Turkish Central Bank's August 14, 2017 US$/TL rate) which was awarded on August 14, 2017. In this context a total of 88 building/facilities will be demolished and reconstructed. The new buildings/facilities that are under construction at the 7th MJB to accommodate the F-35A aircraft include; new Hardened Aircraft Shelters (HASs) and hangars, underground pens, Squadron and Headquarter buildings, mess halls, guest houses, maintenance facilities, depots, heating plant, sport facilities, taxi ways, concrete pavement and a National F-35 ITC building. On 17 May 2019 accompanied by Force Commanders, Turkish Minister of National Defence (MoND) Hulusi AKAR visited the 7th MJB Command and obtained first hand information on the current status of ongoing reconstruction efforts. However since the U.S. Department of Defence has suspended shipments of F-35 related materials

© Lockheed Martin

and training equipment to Turkey in April 2019 this step also affected ongoing reconstruction efforts at the 7th MJB and outfitting process for the National Integrated Training Center (ITC-Turkey). The inside of the ITC-Turkey building would be outfitted with furniture, phones and computers and advanced equipment such as classified areas and simulators.

Two TurAF pilots (Major Halit OKTAY and Major M. Onur KARA) received their transition training into the F-35 in the U.S. at a Lockheed Martin facility during the second half of 2017 after which they completed Instructor Pilot training and graduaded from the course in March 2018. They will be staying as Full-Time Instructor Pilots in the 63rd Fighter Squadron for a couple of years. The U.S. Air Force (USAF) activated the 63rd Fighter Squadron on August 1, 2016 at Luke AFB to train TurAF F-35A pilots. The 63rd Fighter Squadron (FS) is one of three fighter squadrons in the 56th Fighter Wing that train F-35 pilots. The TurAF maintenance personnel (maintainers) are trained at Eglin AFB in Florida. According to the original training plan, during 2018-2020 a total of 332 TurAF personnel/trainees, including 13 pilots, will receive training at Luke AFB and Eglin AFB and training of the TurAF F-35A pilots and technical personnel/maintainers will start to take place at ITC-Turkey at the 7th MJB Command in Malatya from 2020 onwards.

Turkish pilots and maintainers arrived at Luke AFB in June 2018 to begin training on their first two F-35As. On 28 August 2018 Major Halit OKTAY carried out the first solo flight with the F-35A AT-01 (TurAF serial number 18-0001, 15-259) at Luke AFB. With this flight Major OKTAY became the first TurAF pilot to fly the F-35A Lightning II jet. As of 1 June 2019 TurAF trainees at Luke AFB and Eglin AFB consist of 42 students (including 4 pilots who received Transition and Instructor Pilot training). 18 of these trainees are scheduled to complete their training in June, 12 are scheduled to complete training in July, 10 are scheduled to complete training in August and 2 are scheduled to complete training in September 2019.

TurAF F-35A Deliveries & Tension Between Turkey and the U.S. Over S-400 Purchase

The TurAF receieved delivery of its first two F-35As AT-01 (serial number 18-0001) and AT-02 (serial number 18-0002) in June 2018. The 3rd (serial number 18-0003) and 4th (serial number 18-0004) F-35As, were delivered in March 2019 and joined the TurAF F-35As at Luke Air Force Base (AFB) in early April 2019. Third F-35A arrived at Luke AFB on 3 April and the fourth F-35A arrived at Luke AFB on 5 April Friday. These four F-35As will stay at Luke AFB and will be utilized in training TurAF pilot and maintenance personnel in the U.S. until December 2020. The TurAF's 5th (AT-05) and 6th (AT-06) F-35As have been scheduled to be delivered to Turkey in November 2019 and are planned to be flown by Turkish pilots to the 7th MJB in November of 2019, with several air-to-air refueling serials. By the end of 2019 the TurAF is expected to receive further two F-35As (7th and 8th aircraft) and all of these four (5th, 6th, 7th and 8th) F-35As would serve at the 172nd Squadron/F-35A OCU at the 7th MJB. However, delivery and transfer of the future F-35A Lightning IIs to Turkey has been stalled by the U.S. in 2018, so even the fate of the delivery of the F-35As to Turkey has yet to be determined.

Over the purchase of the S-400 Triumph Air and Missile Defence System (AMDS), Turkey and the U.S. have entered a prolonged period of strained ties and the tension has continued to flare up since the beginning of 2019 as the delivery of the Russian-made system to Turkey draws near. U.S. officials have suggested that Turkey buy the U.S. Patriot PAC-3 AMDS rather than the S-400, arguing it is incompatible with NATO systems and is a threat to the F-35 Lightning II aircraft. In an attempt to persuade Turkey to drop its plans to buy the S-400, the U.S. has offered a discount in the Patriot PAC-3 deal that expired at the end of March 2019. Turkey has shown interest in the Patriot AMDS, but not at the expense of abandoning the S-400. The U.S. and other NATO allies that own F-35s fear the radar and other sensor systems on the S-400 Triumph AMDS will learn how to spot and track the jet, making it less able to evade Russian weapons. "The S-400 would collect other types of data that would be helpful to anyone who doesn't have the F-35," Pentagon Spokesman Lt. Colonel Mike ANDREWS told reporters in 2018. Turkey, on the other hand, has emphasized that the S-400 Triumph AMDS would not be integrated into NATO operability and therefore would not pose a threat to the alliance.

Tensions between the U.S. and Turkey have reached a fever pitch in recent weeks and are expected to trigger congressional sanctions against Turkey. The sanctions, if implemented, could also affect Turkey's ability to obtain further CH-47F Chinook heavy-lift helicopters, T70 Black Hawk utility helicopters and spare parts for the F-16 fighter jets.

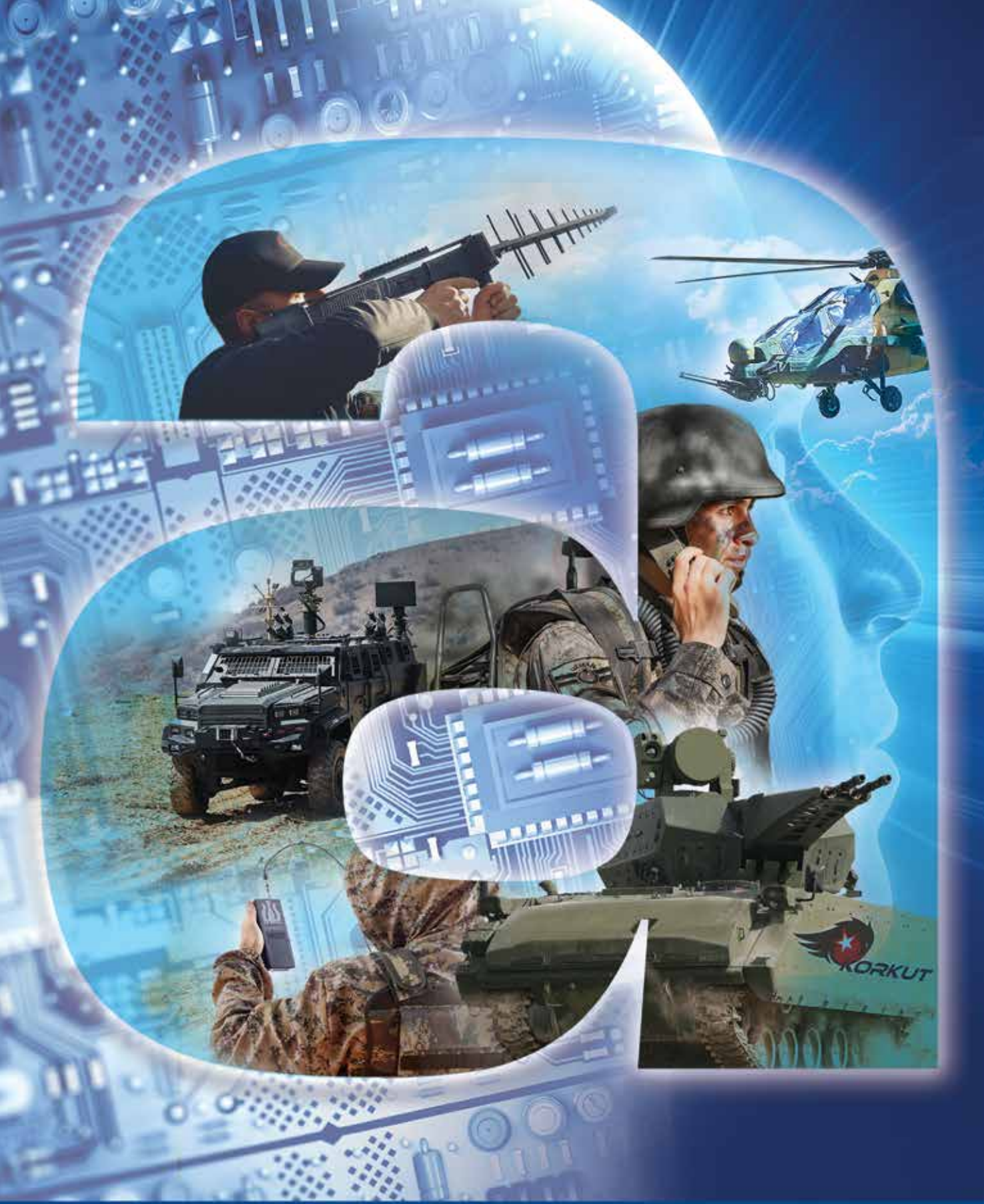
On 18 June 2018 the U.S. Senate passed a US$716 Billion National Defence Authorization Act (NDAA), a Defence policy bill, for

the fiscal year 2019, which included an amendment that would block the transfer of future F-35 aircraft to Turkey if the country would not cancel the S-400 Triumph Air and Missile Defence Systems purchase. The NDAA law draft was approved by US President Donald TRUMP on 13 August 2018. On 28 March 2019 Thursday four U.S. Senators introduced a bipartisan bill to prohibit the transfer of F-35 JSF aircraft to Turkey until the U.S. Government certifies that Ankara will not take delivery of Russian S-400 AMDS. After months of warnings, on 1 April 2019 the U.S. has stopped delivery of F-35 fighter jet parts and training equipment (including F-35 simulators) to Turkey, which are needed to prepare for the arrival and deployment of TurAF F-35As at the 7th MJB Command. "Until they forgo delivery of the S-400, the U.S. has suspended deliveries and activities associated with the set-up of Turkey's F-35 operational capability. Should Turkey procure the S-400, their continued participation in the F-35 program is at risk," said acting Pentagon Spokesman Charles SUMMERS Jr. This decision also marks the first concrete U.S. step to block delivery of the F-35s to its NATO Ally in light of Ankara's planned delivery of first 4th Generation S-400 AMDS in June/July timeframe from Russia. On 15 May 2019 Senior U.S. lawmakers introduced a resolution in the House of Representatives expressing concern over U.S. - Turkish relations and calling for the cancellation of Turkey's F-35 JSF purchases if it acquires Russian S-400 Triumph AMDS. The resolution also called for sanctions on Turkey through the Countering America's Adversaries Through Sanctions Act (CAATSA) if it acquires the Russian missile system.

According to the Countering American Adversaries Through Sanctions Act (CAATSA), which was signed by President TRUMP on 2 August 2017 the U.S. shall apply economic sanctions to all states/countries making major arms transactions with Russia, Iran or North Korea. The CAATSA sets the ground for such measures to be taken against Turkey should it proceed with the S-400 contract rather than acquire a Western made weapons system. According to the F-35 JSF PSFD MoU, "Disputes among the Participants arising under or relating to this MoU will be resolved only by consultation among the Participants and will not be referred to an individual, to a national court, to an international tribunal, or to any other person or entity for settlement," however it is not clear whether this clause also covers the potential decision of the U.S. Government regarding the removal of Turkey from the JSF Program."

However, Turkish President Recep Tayyip ERDOĞAN has refused to back down from Ankara's planned purchase of a Russian S-400 missile defence system and continues making strong statements in support of Turkey's S-400 purchase from Russia. On 5 May 2019 Vice President Fuat OKTAY said Turkey would never bow to U.S. sanctions over its agreement to purchase Russian S-400 AMDS. "We've sent personnel to Russia for S-400 training that will begin in the coming days and will span the following months," Turkish MoND Hulusi AKAR told a group of journalists on 21 May 2019. "Turkey is also making preparations for the potential implementation of Countering America's Adversaries Through Sanctions Act (CAATSA) sanctions," the MoND added. On 23 May 2019 Turkish Deputy Foreign Minister Yavuz Selim KIRAN has noted that Ankara opposed the U.S. sanctions under the CAATSA because the deal with Moscow on the S-400 was signed before the law was passed. Speaking on the F-35 Program on a televised interview held on Monday, 27 May on Haber Turk TV channel, Turkish MoND AKAR stated that an undisclosed number of Russian technical specialists would pay a visit to Turkey to assist with putting Russian-made S-400 missile systems into operation. "The matter of the S-400 purchase is closed. It should be understood that it's a done deal. Our President has repeatedly said that. Technical personnel will arrive from Russia to install the system," the MoND said without giving the exact timeframe of the visit. During this televised interview MoND AKAR also underlined that the delivery of Russian-made S-400 systems to Turkey might be delayed until after June, but they would be deployed in the following months. MoND AKAR previously said that the deployment of the first S-400 AMDS in Turkey, of which deliveries are scheduled to start in the June/July time frame, would begin in October 2019. Russian officials stated earlier that they would start the shipment of initial parts of the S-400 Triumph AMDS batteries in June 2019.

On Wednesday, 29 May, speaking at Berstein's Strategic Decisions Conference in New York, Lockheed Martin CEO Marillyn HEWSON downplayed the impact of a potential U.S. ban on Turkey's purchases of the F-35 JSF, saying they will be fine if Ankara buys a Russian air-defence system instead of the F-35s jets and other countries are already angling for Turkey's F-35As. Japan plans to buy additional F-35s and Polish Defence Minister Mariusz BLASZCZAK disclosed on 28 May 2019 that Warshaw has requested to buy 32 F-35As from the U.S. "Today we sent a Request for Quotation (LOR) to our American partners regarding the purchase of 32 F-35A aircraft along with a logistics and training package," BLASZCZAK tweeted. Tokyo has planned to add 63 F-35As and 42 F-35Bs to its order, in addition to the already placed request for 42 F-35As. The Japanese Air Force has lost one of its F-35As when the stealth fighter jet crashed into the Pacific Ocean on 9 April 2019 during an exercise because the 41-year-old pilot, who had only 60 flying hours in the F-35A, lost his "spatial awareness". Vice Adm. Mat Winter, the F-35's Program Executive, said in April 2019 that 50-75 aircraft could be delayed over a two-year period if Turkey is removed from the JSF Program. President ERDOĞAN, on the other hand, on Tuesday, 30 April 2019



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stressed that the F-35 JSF Program would collapse if Turkey did not participate.

Following the Turkish MoND AKAR's acknowledgement that Turkish military personnel had been sent to Russia for training on the S-400 AMDS, in early June 2019 the then Acting U.S. Secretary of Defence Patrick SHANAHAN (he served as Acting Secretary of Defence from 1 January 2019, to 23 June 2019 and announced his resignation on 18 June 2019. U.S. President TURMP named Mark T. ESPER, the Secretary of the Army and a former Raytheon Executive, to take over as Acting Secretary of Defence) took significant steps toward cutting Turkey out of the F-35 JSF Program over concerns about planned delivery of the first Russian S-400 Triumph AMDS Battery to TurAF in June/July 2019 time frame. In a letter signed on 6 June to Turkish MoND AKAR, the then Acting U.S. Secretary of Defence SHANAHAN told his Turkish counterpart that the 42 TurAF students/trainees (4 pilots and 38 maintainers) attending F-35 training at Luke AFB in Arizona and at Eglin AFB in Florida must leave the country by 31 July 2019 and training for new students has been halted. The 31 July 2019 deadline would allow 30 of the 42 TurAF trainees to complete their training, but the remainder would be sent home before their training naturally concluded. According to the letter, all TurAF personnel, including 2 instructor pilots, in the U.S. related to the F-35 JSF Program will be required to depart the country. And since all of their international travel orders will be cancelled, the TurAF personnel will be prohibited from entering the Luke AFB or Eglin AFB and applicable buildings. According to the letter all actions taken on the F-35 are based on the risks that the S-400 presence in Turkey would have and they are separate from the Russia-related CAATSA sanctions. In addition to sending the existing TurAF trainees back to Turkey, training for the 34 Turkish students scheduled to arrive in the U.S. later this year - 20 in June and 14 between July and November - will be also suspended, according to the document.

In addition, the document states that Turkish Defence and Aerospace Industry will receive no new workshare in the F-35 JSF Program; its existing work "will be transitioned to alternate sources as they are qualified". Major Turkish suppliers that are taking part in the program are planned to be eliminated from the F-35 JSF Program starting from early 2020 and their work pages would be transferred to other countries unless Turkey reverses course on its plan to deploy S-400 Triumph ADMS from July 2019 onwards. "Turkey still has the option to change course. If Turkey does not accept delivery of the S-400, we will enable Turkey to return to normal F-35 Program activities," Ellen LORD, Undersecretary of Defence for Acquisition and Sustainment at U.S. DoD, told reporters on 7 June 2019. The U.S. Department of Defence (DoD) has repeatedly warned Turkey over the past year that the purchase of the S-400 AMDS would result in the suspension of Turkey's participation in the F-35 JSF Program and in April 2019 suspended delivery of F-35 materials and related equipment to Turkey including AT-05 and AT-06 aircraft, which were previously scheduled to be delivered to Turkey in November 2019 and had originally planned to be flown by Turkish pilots to the 7th MJB during November of 2019.

However, according to reports dated 10 June 2019 even the U.S. DoD formally gave Turkey a deadline of 31 July to scrap the deal for S-400 Triumph AMDS, the USAF has already grounded the 6 TurAF pilots, 2 Instructor Pilots and 4 student pilots, training on the F-35 JSF jets in the U.S. and cut off their access to the aircraft's restricted information due to "safety" concerns. According to U.S. media Brig. Gen. Todd D. CANTERBURY, Commander of the 56th Fighter Wing, on Friday, 7 June 2019 made the decision to immediately ground the TurAF pilots and restrict their access to the "vault," which holds state secrets and classified materials. The 63rd Fighter Squadron (FS) is one of three fighter squadrons in the 56th Fighter Wing that train F-35 pilots. According U.S. the grounding was billed as an "operational pause" so that if Turkey decides to scrap the S-400 deal at the last minute, the TurAF pilots would resume their training.

Should Turkey move forward with the S-400 purchase, it could trigger additional sanctions from the U.S. Congress as part of CAATSA Meanwhile according to Haber Türk, production of the first S-400 Triumph System destined to the TurAF has been completed and the system comprising two batteries left the final assembly line on 4 June 2019 following the uploading of special software into the system with the participation of Turkish officials. Haber Türk also claimed that a special Russian Team to be formed with 9 personnel will pay a visit to Turkey during 27-28 June 2019 to take part in the deployment of the first S-400 battery in Turkey. According to Haber Turk, Russia plans to complete deployment of the first TurAF S-400 Triumph battery until 15 July 2019.

On 16 June 2019 speaking to reporters on his plane while returning from a visit to Tajikistan, where he attended a summit and met Russian President Vladimir PUTIN, President Recep Tayyip ERDOĞAN announced that delivery of the Russian-made S-400 Triumph Air & Missile Defence Systems would begin during the first half of July 2019. ERDOĞAN also underlined that he would discuss the issue with U.S. President Donald TRUMP when they meet at the G-20 Osaka Summit, held on 28-29 June 2019 in Japan. Regarding the possibility of Turkey's expulsion from the F-35 Program and the U.S. sanctions to be imposed against Turkey on 20 June 2019, ERDOĞAN said, "If the U.S. does something wrong, Turkey will appeal to international courts to be refunded its investments in the F-35 Program. The U.S. should think carefully before imposing sanctions on Turkey, we will respond with reciprocal sanctions." Addressing his party's group meeting at the Turkish Parliament on 25 June President ERDOĞAN said, "We will, hopefully, start receiving the S-400 air defence systems, which we ordered, next month.""The S-400 issue is directly related to our sovereignty, and we will not backtrack from that."

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F135 Turbofan Engine MRO&U Capability

Turkey has been given the approval to build/assemble its own F135-PW-100 turbofan engines and on 11 December 2014 was also assigned by the U.S. Department of Defence to be the first with European Regional F135 Engine Maintenance Repair Overhaul & Upgrade (MRO&U) capability.

For this purpose, the Engine Final Assembly/Check-Out (FACO) Line and the European Region Depot-Level Maintenance (DLM) Center is being established at the 1st Air Maintenance Factory Directorate (1st AMFD, the former 1st Air Supply Maintenance Center [ASMC]). A signing ceremony between the SSB and TEI for the JSF Project Engine Final Assembly Line Establishment, Activation and the 1st AMFD T-11 Test Cell Modification Phase Project' was held on March 23, 2017 at the SSB Headquarters in Ankara, Turkey. The contract that became effective on 19 December 2017 and has a three-year schedule covers the establishment of the FACO Line at Hangar #10 of the 1st AMFD and the modification of the T-11 Test Cell at the 1st AMFD.

According to contract the F135 FACO Line (for both the F135-PW-100 and F135-PW-600 type engines) will be established in 34 months and the modification of the T-11 Test Cell will be completed in 33 months. Following the completion of modification studies the T-11 Test Cell will gain the necessary capabilities and features for the testing of 5th Generation aircraft engines. According to the original schedule the qualification of the first F135-PW-100 engine and the T-11 Test Cell would be completed in the third quarter of 2020. With this capability the 1st AMFD would be able to perform F135 engine Depot Level Maintenance, Repair, Overhaul and Upgrade (MRO&U) activities of all F-35A and F-35B aircraft, to be procured by the European Countries under the F-35 Joint Strike Fighter Program. According to the SSB with F135 Engine MRO&U capability Turkey will be able to provide DLM service to at least 100 F135 engines per year starting from 2024.

Construction of the Hangar #10 of the 1st AMFD was completed on 23 April 2019 and outfitting phase has been started. However since the U.S. Department of Defence has stopped delivery of F-35 materials and related equipment to Turkey in April 2019 this step also affected ongoing construction and outfitting process for the Engine Final Assembly/Check-Out (FACO) Line and the European Region Depot-Level Maintenance (DLM) Center at the 1st AMFD in Turkey. According to Elen LORD, U.S. DoD Undersecretary of Defence for Acquisition and Sustainment, the U.S. DoD has decided to stop its efforts to open a Pratt and Whitney F135 engine DLM Center in Turkey, instead, it will shift work to two European facilities unless Turkey will cancel the S-400 Triumph AMDS purchase from Russia and will stop delivery of the systems. On 14 May 2018 President of Defence Industries (SSB) İsmail DEMİR Ph.D. paid a visit to the 1st AMFD and inspected Hangar #10 and obtained first hand information on the T-11 Test Cell modification studies. SSB President DEMİR, on the same day wrote the following on his Twitter page: "As an F-35 project partner, we are continuing to fulfill all of our responsibilities and share of work."

TF-X: National Combat Aircraft

The TF-X (Turkish Fighter – Experimental) is a proposed single seat, twin-engine all-weather air superiority fighter being developed by Turkish Aerospace (Turkish Aerospace) with technological assistance from BAE Systems.

In order to meet Turkish Air Force (TurAF) requirements beyond 2030, the National Combat Aircraft (which is abbreviated as MMU in Turkish), also known as TF-X, Development Program was launched in accordance with Decision No 545 adopted at the Defence Industry Executive Committee (DIEC) dated 15 December 2010. The MMU/TF-X was planned to replace the F-16C/D Fighting Falcon combat aircraft during the 2030s and Turkish Aerospace (Turkish Aerospace) was selected as the Prime Contractor.

The contract for the Conceptual Design Development Project was signed between the Turkish Presidency of Defence Industries (SSB) and Turkish Aerospace on 23 August 2011. Under the contract, involving a 24-month schedule which came into force on 29 September 2011, between 2011-2013 Prime Contractor Turkish Aerospace prepared three separate conceptual designs with technical support provided by SAAB Aircraft, selected as the Technical Support and Assistance Provider (TSAP). These three configurations are named as follows: FX-1 (configuration with double engine, back wing and conventional tail design such as F-18, Eurofighter, Rafale and Mig-29), FX-5 (configuration with single engine, back wing and conventional tail design) and FX-6 (configuration with single engine, broad delta wing and front wings). Under the 'Concept Development and Preliminary Design Phase', on 29 September 2013, Turkish Aerospace submitted the report for the designs and the results of the efforts carried out during the past two years to the SSB.

As a result of the proposal evaluations conducted during the Foreign Cooperation Company (FCC/YIF) selection process, it was decided to begin negotiations for the contract with British company BAE Systems on 12 November 2015 and as of December 2015, the Pre-Contract Studies with BAE Systems commenced. During the fourth quarter of 2016, the SSB and Turkish Aerospace confirmed that MMU/TF-X Program would go ahead with the single seat, twin-engine FX-1 design. The Preliminary Design (Phase-I Stage-I) contract was signed between Turkish Aerospace and SSB on 5 August 2016 and on 28 January 2017 in the presence of the Prime Ministers of Turkey and the United Kingdom, BAE Systems and Turkish Aerospace signed a US$156 Million agreement to collaborate under the Preliminary Design (Phase-I Stage-I) Phase of the MMU/TF-X Program. The Turkish Aerospace-BAE Systems Collaboration Agreement became effective on 25 August 2017.

The Project Implementation Schedule (To) was started on 17 September 2018 following the selection of TR Motor as the Prime Contractor and Supplier for the turbofan engines that will power the TF-X production aircraft. In October 2018 Turkish Aerospace selected General Electric (GE)'s F110 Turbofan Family, specifically the F110-GE-129 or F110-GE-132, to power the MMU/TF-X prototypes and initial batches of series production aircraft. On 8 November 2018 the SSB signed a Framework Agreement with TR Motor Power Systems for the development of a next generation turbofan engine that will power the MMU/TF-X, the Turkish Fighter aircraft. To support the MMU/TF-X Program Turkish Aerospace is establishing a new infrastructure in its facilities in Ankara. In this context for example, to carry out the MMU/TF-X Program Turkish Aerospace is constructing a new facility at the Ankara Aerospace Industrial Zone, a total of 2,700 engineers will be employed at this facility. Moreover, on 2 May 2019, during the IDEF '19 Fair held in Istanbul, Turkey, Turkish Aerospace signed an agreement with Aiolos Engineering Corporation, based in Canada, for the construction of a ''Subsonic Wind-tunnel'' at the Turkish Aerospace facilities in Ankara to support the MMU/TF-X and other future programs. Turkish Aerospace aims to build one of the World's three ''Subsonic Wind-Tunnels", and put it into operation in 2023. Turkish Aerospace also previously signed a contract on 19 July 2018 with the company Aircraft Research Association

(ARA), an independent research and development organization providing a range of specialist services to the worldwide aerospace industry, of the UK regarding the risk reduction phase of the wind tunnel tests for the TF-X aircraft. The highest level of quality wind tunnel data is required to verify an aerodynamic design. Since Turkey presently lacks a sufficient infrastructure in high-speed wind tunnel testing, there is a plan to utilize BAE Systems capabilities in this field during TF-X's wind tunnel test phase especially at supersonic speeds. The BAE Systems Wind Tunnel facility is home to two tunnels, known respectively as the low speed and high-speed tunnels. In the latter, tests can be carried out at speeds up to Mach 3,8, which makes it perfect for transonic work.

The MMU/TF-X Program will be carried out under three Phases as the Preliminary Design (Phase-I Stage-I, September 2018 - September 2022), Detailed Design & Qualification (Phase-I Stage-II, September 2022 – September 2028), Acquisition of Initial Operation Capability and Full Operation Capability (IOC/FOC, Phase-II, September 2028 – December 2031) and Serial Production (Phase-III, 2032-2035+). Turkish Aerospace was designated as the Prime Contractor for the MMU/TF-X Development Program's Engineering Development & Preliminary Design Phase in line with the DIEC Decision made in April 2015. Under the Engineering Development & Preliminary Design Phase, which will end up with completion of the Preliminary Design Review (PDR) document, beyond the design and development of the TF-X aircraft, engineering capabilities, technology development activities (for key sensors like radar, electronic warfare, etc.), test infrastructure establishment and certification processes will be performed and extensive capabilities for a new generation jet fighter design, development and production will be gained by the Turkish Defence & Aerospace Industry.

As of June 2019, the Engineering Development & Preliminary Design Phase (Phase-I Stage-I) is continuing and is scheduled for completion in September of 2022. Developing a stealth fighter is an expensive enterprise. The 4-year schedule for the Preliminary Design Phase is expected to cost around US$1,3 Billion (according to Turkish Aerospace President & CEO Temel KOTİL around US$300-400 Million of this figure will be allocated for infrastructural investment and around US$1 Billion for the engineers) and to be followed by a 9-year Detailed Design & Qualification schedule (which also covers Critical Design Review [CDR] and Prototype Production and the Qualification Phase) and the Acquisition of IOC/FOC, which are estimated to cost around US$7,3 Billion. At the end of 13-years and US$8,6 Billion (US$8,2 Billion is expected to be spent until the first prototype's maiden flight) in expenses, a total of seven MMU/TF-X prototypes (six for flight tests and one for ground tests) in three different configurations dubbed Block-0 (first test model which will be rolled out in 2023), Block-I (air-superiority model planned to achieve IOC in 2028) and Block-II (multi-role model with air superiority plus air-to-ground capabilities, planned to achieve FOC in 2031) will be manufactured for test, evaluation and qualification purposes. Another US$14 Billion is earmarked for the Serial Production of the MMU/TF-X fighters.

Temel KOTİL - CEO & President of Turkish Aerospace, Paris Air Show'19

According to Turkish Aerospace President & CEO KOTİL, during next 10-year period a total of 10,000 Turkish and foreign (including those from BAE Systems) engineers from different disciplines, those with supersonic fighter design and manufacture experience (know-how) will work under the MMU/TF-X Program. Under the contract BAE System will provide 400 personnel/year engineering support for a period of 4 years to Turkish Aerospace under the Engineering Development & Preliminary Design Phase (Phase-I Stage-I) of the MMU/TF-X Program. As of June 2019 a total of 300 Turkish Aerospace engineers from different disciplines are currently taking part in MMU/TF-X design activities. BAE Systems supports design of the MMU/TF-X with some 100 engineers based in Ankara.

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F100-GE-129 Turbofan Engine

Turkish Fighter and Indigenous Turbofan Engine

The MMU/TF-X, or Turkish Fighter (Turkish Aerospace, refers to this program as Turkish Fighter [TF] and exclude the X at the end of its title with an emphasis that it is no longer an Experimental aircraft) will be a single-seat, twin-engine combat aircraft (based on FX-1 concept) with Low Observability and Super Cruise capabilities and is to be equipped with indigenously developed systems and sensors. Replacing the F-16C/Ds currently in the service of the TurAF during the first quarter of the 2030s, the Turkish Fighter will be a fifth-generation indigenous air superiority fighter with secondary ground attack capability, which will escort and provide air protection to the TurAF's F-35A Lighting II fleet. The TurAF currently operates 238 F-16C/D aircraft and Turkey is likely to procure some 150 TF-X in the long term to replace F-16s.

In December 2017 Turkish Aerospace released the technical specifications of the Turkish Fighter. According to Turkish Aerospace, the Turkish Fighter will measure 19 meters (60ft) long, have a 12-meter wingspan, around 60m² (670ft²) wing area and a maximum takeoff weight (MTOW) of 60,000lbs+ (27,215kg+). Powered with a pair of over 20,000lb class turbofan engines, the Turkish Fighter is intended to have a maximum speed of Mach 2, a service ceiling of over 55,000 feet, and a combat radius of over 600 nautical miles according to the Turkish Fighter technical specifications document.

However following the selection of bigger and more powerful engines to power prototypes and series production aircraft the technical specifications of the Turkish Fighter have also been changed. According to Turkish Aerospace engineers taking part in Turkish Fighter design activities, the length of the fuselage has been extended to accommodate larger engines and to stabilize the extended fuselage wingspan dimension which has been enlarged. Moreover, in order to provide better air-flow into new more powerful engines the design of the air intakes have been revised and enlarged. As a result of these revisions on the aircraft design, which stem from the selection of bigger and more powerful engines, the length of the Turkish Fighter has been increased to 21 meters and its wingspan has been increased to 14 meters. The Turkish Fighter will have a maximum speed of Mach 1.8 while running on two engines (each generating 27,000 lb thrust). It will also have a height of 6 meters, maximum takeoff weight of 60,000 lb, a maximum altitude of 55,000+ feet, and a combat radius of 600+ nautical miles.

After several years of confusion surrounding the Turkish Fighter (TF)'s engine choice, TR Motor Power Systems, a national engine consortium (formed by BMC Power [55%], Turkish Aerospace [35%] and the SSB [10%]) was created and became operational in April 2018 to develop a 27,000 lb class indigenous turbofan engine for TF production models. Within the scope of efforts initiated regarding the procurement of turbofan engines to power the TF prototypes and the initial batches of series production aircraft, in October 2018 Turkish Aerospace selected General Electric (GE)'s F110 Turbofan Family, specifically the F110-GE-129 or F110-GE-132. The F110-GE-129 has a maximum thrust rating of 29,500 lb, while the F110-GE-132 produces up to 32,000lb of take-off thrust. The F110-GE-129 Turbofan Engine with a thrust capacity of 129kN are currently employed in F-16C/D Blok 50 (F110-GE-129 IPE) and Blok 50+ (F110-GE-129B) aircraft in TurAF service. Featuring a radial rather than a spray-bar augmentor design and incorporates a number of component differences to improve durability the F110-GE-132 (142kN) Engine is used on F-16E/F Desert Falcon aircraft in the inventory of United Arab Emirates (UAE) Air Forces. Incorporating an all-bladed disk (blisk) fan and new low-loss radial A/B, the F110-GE-132 grew the F110 Family to 32,000lb of thrust, a 10% increase over the F110-GE-129. The higher thrust of the -132 is accomplished without a physical size increase and required no changes to the F-16 inlet. F110-GE-132 has latest state of the art technology, culminating 32,000lb of

F-16D Block 50+

thrust, making it the highest thrust engine available in its class at. According to GE, the capability of a 10-20% thrust growth still exists within the current engine envelop. So, the current F110-GE-132 could be developed to offer 35,000lb (155,7kN) of take-off thrust to satisfy a new-platform requirement.

The F110 Turbofan Family is a stopgap solution until Turkey has built its indigenous turbofan engine for the MMU/TF. On 8 November 2018 the SSB signed a Framework Agreement with TR Motor Power Systems for the development of a next generation turbofan engine that will power the MMU/TF or Turkish Fighter, aircraft. Speaking at the signing ceremony SSB President İsmail DEMİR said the final goal is that the engine would not face limitations from foreign countries in terms of use and exports, and for Turkey to control all technological features and Intellectual Property (IP) rights. SSB President DEMİR noted that development of the indigenous turbofan engine would be a long process, nearly 10 years, and the agreement that was signed with TR Motor will serve as a framework in this process. On the occasion of the signing ceremony on 8 November a computer generated image (CGI) of TR Motor's Turkish Indigenous Turbofan Engine was also shared with the media. Our initial analyses suggest that the current design has several similarities in terms of internal configuration with the F110 Turbofan Family. In this context for example, like the F110-GE-129 and -132 engines Turkish Indigenous Turbofan Engine also features Variable Inlet Guide Vane and as in the case with the F110-GE-132 engine it features "blisks" (bladed-disks) in the three-stage modular fan section in lieu of traditional blades to improve performance and maintainability. The engine also incorporates one High Power turbine (HPT) and a Low Power Turbine (LPT). According to our sources the Turkish Indigenous Turbofan Engine to be supplied by TR Motor Power Systems will have similar dimensions and weight with F110 Turbofan Family. Speaking on the MMU/TF Program on a televised interview held on 13 June 2018 President of Defence Industries (SSB) Prof. DEMİR had underlined


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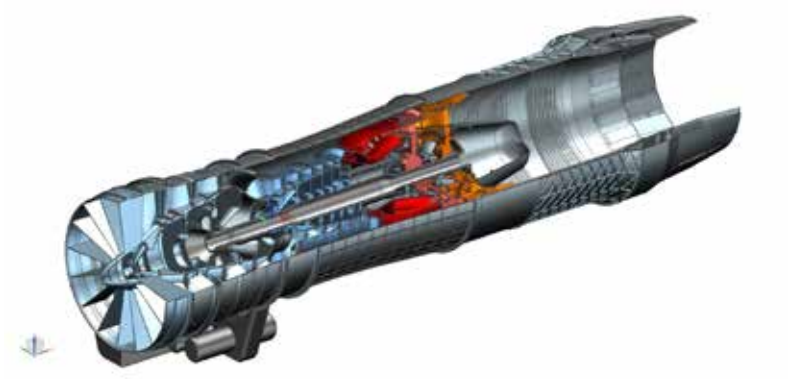
that as of June 2018 50 engineers were working/studying on Turkish Fighter engine and 10 experienced and valuable engineers have been brought to Turkey from abroad via reverse brain drain. SSB DEMİR had also stressed that knowledge on aircraft engines in Turkey would be gathered under the umbrella of the TR Motor Power Systems. TR Motor Power Systems facilities (dubbed as Technology Base) is located at Hacettepe Teknokent (Technopolis) in Ankara.

According to Turkish Aerospace engineers taking part in Turkish Fighter design activities under the Detailed Design & Qualification (Phase-I Stage-II, September 2022 – September 2028) Phase, a total of seven Turkish Fighter prototypes (six for flight tests and one for ground tests) in three different configurations namely; Block-0, Block-I and Block-II however during the Paris Air Show 2019 it was reported that there will be five Turkish Fighter prototypes. On June 23, 2019 Turkish Aerospace President & CEO Temel KOTİL disclosed that they have ordered 5 turbofan engines from General Electric (GE) and at the moment they are at delivery sate. "We will use F-16 engines (probably F110-GE-129E version due to twin engine configuration) in the first prototypes of TF-X in first flights. Development of indigenous turbofan engine is continuing" KOTİL added. We estimate four of the engines will be installed on two of Turkish Fighter prototypes and the fifth engine will be used as spare.

If Turkey proceeds with the S-400 Triumph AMDS contract rather than acquiring a Western made weapons system, the U.S. will apply economic sanctions on Turkey under the CAATSA. This, in turn, could make it difficult for the U.S., and even European defence companies to conduct business in Turkey. In this context, the U.S. Congress could also block any cooperation (such as the transfer of turbofan engines, avionics and sub-systems) between U.S. companies with Turkey over the MMU/TF Program. In such case it is clear that Turkey will not be able to afford to keep the MMU/TF Program on schedule and will potentially face significant drawbacks to turn the project into a reality.



Turkish Aerospace Revealed a Mock-up of Turkish Fighter at the Paris Air Show 2019

During the Paris Air Show, on 17 June 2019 Turkish Aerospace unveiled a full-sized mock-up of its next generation fighter the Turkish Fighter. Speaking at the one-to-one mock-up of a Turkish Fighter aircraft presentation, Turkish Aerospace President & CEO Temel KOTİL said that when it enters the service, the Turkish Fighter will be "the best fighter in Europe" and capable of carrying the long-range, air-to-air METEOR missile of the European manufacturer MBDA. "We have increased our speed ... we have enough strength to build this fighter," he added. Previously, the company had revealed its intentions to fly the Turkish Fighter in 2026. However during his address, Turkish Aerospace President & CEO KOTİL disclosed that the aircraft would be completed in 2023, with first flight in 2025 and the next generation fighter will enter service with the Turkish Air Force (TurAF) in 2028. "Once we develop the Turkish Fighter, we will become the world's fourth country to have this type of aircraft. Meanwhile; Japan, the Republic of Korea, Iran and India are also working on similar projects. So there is a competition between countries," KOTİL added. The ceremony was attended by Royal Malaysian Air Force (RMAF) Commander General Tan Sri Dato' Sri Affendi bin BUANG. Turkey has been looking for international joint development partners to collaborate with Turkish Aerospace and various Turkish sub-contractors on the MMU/TF Program, and Malaysia is one of the potential candidates for this role.

According to reports, the full-size mock-up Turkish Fighter, which was constructed by recently established Turkish Aerospace-KALAY Joint Venture Company in Germany in 35 months, cost the company almost Euro2 Million (US$ 2,25 Million). According to Turkish Aerospace, the METEOR active radar guided beyond-visual-range air-to-air missile (BVRAAM) was selected by the TurAF for the Turkish Fighter since the beginning of the Program and during the Conceptual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Design Development Phase, which was carried out between September 2011 – September 2013, necessary information was obtained from the manufacturing company to integrate the METEOR missile into the Turkish Fighter and aircraft design (such as weapons bay) was prepared in accordance with METEOR missile's technical specifications.

Within the course of the Turkish Fighter development program, new capabilities and equipment will be added to the aircraft under a "Block Development Approach". In each Block, the level of local content ratio will also be increased. The first Turkish Fighter prototype will be in Block-0 configuration and is expected to be rolled-out in 2023, when Turkey will celebrate its 100th anniversary of the founding of the Republic. Following the ground tests, the maiden flight will be performed with the first prototype aircraft. The Block-0 configuration will not feature either stealth capability or some of the main internal avionics and equipment (such as AESA radar) and various sub-systems onboard the aircraft will be procured from abroad such as turbofan engines, integrated cockpit display system (panoramic cockpit display) and landing gears. The Block-I prototypes will be in air superiority configuration and the first aircraft that enter TurAF service in 2028 will be in Block-I configuration. The TuRAF will achieve/declare IOC with Block-I Turkish Fighters. According to Turkish Aerospace, the TurAF originally planned for the first entry into service to occur in 2029 but

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since the company has accelerated its efforts the entry into service date was able to be moved to an earlier time. Turkish Aerospace will start Block-II deliveries in 2031 and following their entrance into TurAF service FOC will be declared. The Turkish Fighter Block-IIs, multi-role model with air superiority plus air-to-ground capabilities, will feature increased local content share thanks to their indigenously developed engines, sub-systems and avionics.

In every aspect of size – height, weight, wingspan, weight – the Turkish Fighter is bigger than the existing 5th Generation fighters including F-22, F-35, Su-57, J-20 and KF-X. Nevertheless, the overall design of the Turkish Fighter mock-up bears similar features (such as twin-engine and canted vertical tail design) to the F-22 Raptor and F-35 Lightning II stealth fighters, but with a narrower and longer fuselage and wider wingspan. The Turkish Fighter has a long and wide fuselage and a chiseled nose section with a frameless canopy. The air intakes are situated immediately behind the cockpit. In order to avoid radar detection the vertical tail of the aircraft has been designed in a canted manner. Further examination shows that all of the surfaces and the edges of the aircraft are smoothly blended, however contrary to many stealth fighter designs the mock-up still has exposed exhaust nozzles (without thrust vectoring capability), perhaps during the next phases of the ongoing development process engines would be buried deep inside the fuselage. The Turkish Fighter also has both cheek and ventral internal weapons bays like the F-22 Raptor.

Even if it will be an all-weather, multirole fighter, the Turkish Fighter's primary role would be air-superiority. Since the aircraft designed for air-to-air combat from the beginning, the Turkish Fighter has weapons bay designed accordingly. The main bay, located on the bottom of the fuselage, can hold up to four launchers for air-to-air medium/long range (Beyond Visual Range/BVR) missiles and air-to-ground munitions and missiles weighing between 250 lb to 2,000 lb. Each of the side weapons bay, on the left and right of the fuselage, can hold two launchers for short-range air-to-air missiles. The Turkish Fighter will also have a total of four (two on each wing) underwing pylons on which both the air-to-air and air-to-ground munitions/missiles (NATO and Indigenous Weapons) can be integrated. Carrying the missiles and munitions on the underwing pylons would cost the Turkish Fighter its stealthiness. Turkish Aerospace has already launched an international tender to procure an undisclosed quantity of Suspension and Release Equipment (SARE) for integration onto Turkish Fighter prototypes and production aircraft. The SARE solution for the Turkish Fighter refers to the suite of equipment required to meet the requirements for carriage and release of a variety of weapons and stores in a variety of locations inside and outside the aircraft. Bidders are asked to submit their proposals by the end June 2019. According to sources the proposal is also covers an option for co-design and co-production of launchers in Turkey. Cobham, which also secured a contract in August 2017 to provide Missile Eject Launchers for the KF-X fighter aircraft is one of the bidders for this tender. Cobham is expected to offer Cobham Mission Systems (CMS) Fox-10 Lightweight (33kg) Advanced Missile Launcher as part of the SARE solution for the Turkish Fighter. The lightweight and ITAR free launcher is designed to carry both Short Range Air-to-Air Missiles (SRAAM) and Beyond-Visual-Range Missiles (BVRAAM)

Aselsan Avionic Lab

HürJet New Generation AJT & LCA Development Project

Development of the Turkish Fighter will likely be preceded by that of the HürJet New Generation Advanced Jet Trainer (AJT) & Light Combat Aircraft (LCA), which Turkish Aerospace hopes will replace T-38M jet trainer fleet in the service of the TurAF.

HürJet New Generation AJT & Light Attack Aircraft is being developed by Turkish Aerospace under a Protocol signed between Turkish Aerospace, the SSB and the TurAF on 2 July 2018. The initial studies for the "Advanced Jet Trainer & Light Attack Aircraft (Hürjet) Project" were started in July 2017 and the Project was officially launched on 14 August 2017, as a company funded project (which was funded from Turkish Aerospace' own resources) after receiving a green light to go ahead from the Turkish Aerospace Board.

The Conceptual Design Phase (CDP) of the HürJet Project was completed in April 2018 as of July 2019 engineering and analysis studies as part of its Preliminary Design Review (PDR) Phase activities have been completed successfully. In this context, TUSAS engineers have recently completed wind tunnel tests with a HürJet's 1/10 model to confirm the existing configuration. Since the HürJet model that underwent the wind tunnel test was configured in accordance with GE's F404-GE-102 turbofan engine, the design of the air intakes will be revised and enlarged to meet more powerful EJ200 engine and further wind tunnel tests will be carried out to confirm revisions on air intake design. The PDR Phase will be followed by the Critical Design Review (CDR) and Test Readiness Review (TRR) Phases. The CDR Phase is scheduled to be launched in 2019 and to be completed in 2020. Where as the Test Readiness Review (TRR) Phase is planned to be completed in 2021. The first HürJet prototype is planned to perform its maiden flight in 2022.

The Hürjet Project is aimed at the development of an indigenous new generation Advanced Jet Trainer (AJT), capable of supersonic flight to replace the T-38M jet trainer fleet in the service of the TurAF, and a Light Combat Aircraft (LCA) able to perform a Close Air Support (CAS) role to assist and release the load on the TurAF's F-16C/Ds shoulders. The indigenous jet trainer HürJet will be utilized to train and prepare pilots for the next generation F-35A and MMU/TF aircraft in the 2030s, replacing the aging T-38M jet trainers in service with the TurAF. Currently the TurAF operates 68 T-38M Advanced Jet Trainers in Advanced Jet Training and Combat Readiness Transition Training at Çiğli Air Base (2nd Main Jet Base Command) in Izmir.

According to Protocol, the HürJet prototypes (a total of five) will be manufactured in two different configurations; the AJT and the LCA. The AJT will be produced in the first configuration while the second will be an armed variant. In the LCA variant, a fire control radar, external payloads (on six external hardpoints and up to 2,721kg [6,000 lb] according to infographic prepared and distributed by the SSB on 22 July 2018), a fire control system and various mission systems will be integrated. The HürJet AJT prototype is expected to perform its maiden flight in 2022 and to enter TurAF service in 2025.

In order to attract the attention of potential international customers Turkish Aerospace previously showcased a full-scale mock-up

(indeed a ground prototype of the aircraft) of the HürJet AJT & LCA, with single turbofan engine (F404-GE-102, which offers 17,000lb thrust with afterburner) and having underwing stores of indigenous air-to-air (GÖKDOĞAN/Peregrine short-range IIR guided AAMs) and air-to-ground (UMTAS and TEBER-82) weapon systems as well as BNA's external fuel tank, for the first time at the Farnborough International Airshow 2018, which took place during 16-22 July, in London, UK.


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As a clean-sheet design the single-engine, twin-seat HürJet will be Turkey's first indigenous supersonic aircraft and one of the world's few supersonic trainers. The aircraft is 13m (42,6ft) in length, 4,2m (13,7ft) in height, has 9,8m (32,1ft wingspan and 24m2 (25831ft2) wing area. The figures related the predicted empty weight and maximum takeoff weight (MTOW) of the aircraft have not been publicized yet. Previously the HürJet prototypes were planned to be powered by a GE's 17,000lb thrust class F404-GE-102 turbofan engine. A number of series productions of HürJet were also planned to be powered by F404 turbofans (to be manufactured under license in Turkey). However in April 2019 Turkish Aerospace changed its decision on the engine type to be installed on HürJet and revised the HürJet's engine thrust from 17,000lb to 19,200lb. At that time Klimov's RD93 turbofan engine, which generates combat thrust of 19,200lb with after burner was considered among the selections. But during Paris Air Show 2019 a Letter of Intent (LoI) was signed between Turkish Aerospace and Eurojet Turbo GmbH for the delivery of EJ200 turbofan engines (single engine configuration). The LoI was signed by Turkish Aerospace President & CEO Temel KOTİL and EuroJet CEO Clemens LINDEN. Since the EJ200 turbofan engine, which is considered to be the benchmark in the 20,000lb thrust class military engine market, was specifically was designed to power the twin-engine Eurofighter Typhoon, two major modifications should be done on the EJ200 to convert it into a single engine fighter engine. Turkish Aerospace also displayed the HürJet mock-up during the Paris Air Show 2019 at its stand. According to the HürJet Technical Specification Table that was on display in front of the HürJet mock-up, the maximum speed of the HürJet will be Mach 1,4 (it was Mach 1,2 with 17,000lb engine); the service ceiling will be 13,716m (45,000ft) and the climb rate will be 35,000ft/minute (it was 25,000ft/minute with 17,000lb engine). The HürJet will be able to perform +8G/-3G maneuver and capable of sustaining 6,5G at an altitude of 15,000ft and up to Mach 0,9 speed. The range of the aircraft will be 2,592km (1,400nm)

Collins Aerospace; “We are Working with Local Turkish Companies to Provide Our Solutions.”

Defence Turkey caught up with Collins Aerospace Vice President for Actuation Systems Mr. Edward DRYDEN, during IDEF ‘19 to get first-hand information on Collins Aerospace Actuation Systems, the current position of the company on the global aerospace market and their involvement in Turkish aerospace programs. We also took the opportunity to ask him about their goals and expectations for the Turkish market. Collins Aerospace Mechanical Systems Business Development Director Mr. David CHARD also accompanied us during the interview.

Defence Turkey: Did IDEF '19 meet your expectations? Did you have an opportunity to meet with the SSB or MoND?

Edward DRYDEN: IDEF more than met my expectations. I've visited many shows in the past but I think that the breadth of products, systems and solutions that are here at IDEF certainly makes it stand out for me. It's a fantastic opportunity to meet with customers and suppliers and potential partners in Turkey. It's a great opportunity to really meet and look for those opportunities where we can reinforce the unmatched potential and value Collins Aerospace will bring to customers to advance the aerospace and defence industry. As you know, with the bidding and engaging with HürJet and TF-X it's not just dealing with Turkish Aerospace, it's a joint effort between Turkish Aerospace and the SSB, so we've had the opportunity to talk together.

Defence Turkey: What types of solutions are you providing, and have you delivered any systems to the Turkish end user and Turkish companies?

Edward DRYDEN: Collins Actuation is one of the largest and well-established providers of actuation systems to the aerospace market. We have been established in the region for decades, providing a complete range of aerospace and defence solutions for ministries of defence, integrators, aircraft manufacturers, airlines and other customers. Collins Aerospace is at the forefront of the industry with latest developments in technology supplying a vast portfolio of Actuation Systems for Fixed Wing, Rotorcraft and Military platforms.

We provide solutions to our customers for a range of actuation products including:

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- Utility Actuation
- Missile Actuation

Our objective is to continue to serve our customers in the region with the highest standards of operational excellence and help them in their future growth with the most innovative and trusted solutions and services.


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Defence Turkey: What about your activities in Turkey?

Edward DRYDEN: Turkey is a very important market for us, and we are one of the main providers. Collins Aerospace in Turkey has been involved in multiple endeavors supplying content on both military and commercial platforms and developing indigenous/local manufacturing capabilities. Collins Aerospace will continue to build upon existing partnerships.

We work very closely with Turkish industry and continue to explore partnership opportunities with companies like Turkish Aerospace, Aselsan, Havelsan, Roketsan and TÜBİTAK. Partnering for success through complimentary collaborations will enable Collins Aerospace and local partners to expand the existing reach.

In terms of actuation systems, we do the Environmental Control System (ECS) on the HürKuş. We also provide the main and tail rotor actuators on the T625. But if you look at the broader Collins Aerospace, we also provide radio and navigation systems on the Black Hawk variant and on the T625 and we have simulation on the F-16 and flight controls on the unmanned vehicles.

Collins Aerospace's expansive portfolio is uniquely positioned to provide Turkish customers with a suite of complimentary products and solutions. Collins defence ecosystems and connectivity are redefining aerospace.

TF-X and HürJet for example are two strategic programs that Collins Aerospace is currently pursuing. Through increasing our existing presence and focus on indigenous content and solutions. We are committed to growing and collaborating with local industry leaders in Turkey. We are encouraged by the growth in the Turkish Aerospace industry and we see opportunities for Collins Aerospace to develop a supply base that we can use for our global projects.

Defence Turkey: Are you providing actuation systems to Turkish UAV manufacturers Turkish Aerospace, Baykar Makina and Vestel Defence?

David CHARD: Yes, we are working with local Turkish companies to provide our solutions.

Defence Turkey: Let's talk about the T625 GÖKBEY Turkish Light Utility Helicopter (TLUH), how many actuation systems are needed for each platform?

Edward DRYDEN: On a helicopter you move the tail rotor and the main rotor, so on the main rotor it normally sits on the swash plate assembly and I believe it's got three on the T625 so you'll have the main rotor actuators and they work in combination and obviously allow you to change the angle of attack. Then on the tail rotor you also actuate the tail rotor head on which


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you have typically one actuator. We developed the entire system, so we will develop all the main rotor actuators together, and we then develop the tail rotor actuators together and we integrate that with Turkish Aerospace into the aircraft.

Defence Turkey: You have already mentioned your role in HürKus, but as you know, there are also the HürJet and TF-X programs. Can you elaborate on Collins Aerospace's involvement in the HürJet and TF-X programs?

Edward DRYDEN: We've been working with Turkish Aerospace for the last 2 years on both the HURJET and the TF-X. We've been supporting them in developing their specifications. Our primary focus with them at the moment has been on the actuation system.

Defence Turkey: What about missile systems? Do you provide any actuation systems for indigenous missile or ammunition systems in Turkey such as the SOM?

Edward DRYDEN: Presently we do not, but we've started to engage with Roketsan to understand if there is any potential for us to bring more value to them. They're interested in what value the Collins group can bring.

Defence Turkey: Can you share figures about how many actuation systems have you delivered so far globally? And your company figures achieved in 2018?

Edward DRYDEN: We delivered a huge number of actuation systems. In 2018 we earned US$1,42 Billion only from our actuation systems business. As I said we are very well positioned in our market.

Defence Turkey: Can you elaborate on how many countries are using your products around the world and on which platforms?

Edward DRYDEN: Collins Aerospace has a truly global presence for the products and services it provides. We have more than 50 years of actuation experience and we are supporting many customers worldwide.

Defence Turkey: Are your products ITAR free? Do you experience any challenges, shortages, and any export limitations with Turkey?

Edward DRYDEN: I have businesses in the US, Canada, the UK, France, Italy and then by extension I've also got business in Indonesia and India. We supply different products from different sites to different customers. It very much depends on the product and where it is going. We are able to create tailor-made solutions dependent on customer requirements for full or partial Actuation Systems. We can also provide Full System Integration and Testing to ensure product performance. So the military products that are supplied for the US will obviously have the ITAR rules. All the products that are


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supplied outside of the US, we will always comply by the appropriate laws and rules of the country in which we are operating.

Defence Turkey: So, your products contain some US technologies that is why they are subject to ITAR regulations?

Edward DRYDEN: In some cases yes but we are also developing non ITAR solutions to support other programs and comply with our customer requirements. For example, the interaction between HürJet and TF-X is being led from our UK business and there are licenses in place between the UK Government and Turkey to enable us to appropriately and legally engage and not attract ITAR.

Defence Turkey: Mr. DRYDEN, thank you for sparing your time for our readers

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Edward DRYDEN with İbrahim SÜNNETÇİ at IDEF'19

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Shaping the Future of European Air Defence Eurosam Opens a New Chapter for Turkey

Mr. Eric DELEPOULLE: “Eurosam offers the ASTER 30 Block 1NT for joint development to support Turkey’s indigenous missile defence development program and strengthen the co-operation between our countries.”

The Eurosam Consortium, which celebrates its 30th anniversary this year, was established in June 1989 by three major European aerospace companies (Aerospatiale, Alenia, and Thomson-CSF) known today as MBDA Missile Systems and THALES for the development of the “Famille de missiles Sol-Air Futurs” (Future Surface-to-Air Family of missiles or FSAF).

The company headquarters is in Paris, with another facility in Rome. Eurosam was initially a joint venture between Aérospatiale, Alenia, and Thomson-CSF. Aérospatiale is part of MBDA France, and the Missile and Missile Systems department of Alenia is now MBDA Italy. Thomson CSF is now Thales Group. Thus, Eurosam is owned by MBDA France and Italy (66%) and Thales Group (33%). Thales is a global electronics company serving the Aerospace, Defence, and Information Technology market worldwide with operations in more than 50 countries and has 68,000 employees; while MBDA missile systems is a world-leading missile systems company with 10,000 employees, an annual turnover of about € 2.5 Billion and over 90 customers across the world. As Europe’s largest and most experienced defence contractors, these companies are both shareholders and subcontractors to Eurosam.

Eurosam was also one of the competitors in Turkey’s multi-billion-dollar anti-missile defence system T-LORAMIDS program in 2010. The Franko-Italian company competed in the tender with its SAMP/T ASTER 30 system against the US partnership of Raytheon and Lockheed Martin, offering the Patriot Advanced Capability-3 (PAC 3) and Guidance Enhanced Missiles (GEM-T); Russian Rosoboronexport, marketing the S-300, and Chinese CPMIEC (China Precision Machinery Import-Export Corporation), offering its FD-2000 (HQ-9) system. Although the Chinese company CPMIEC was awarded the contract by the Undersecretariat for Defence Industries (SSM) for 12 battalions of S HQ-9 in the export model called FD-2000 with an estimated value at about US$ 3.4 billion on September 26, 2013, Turkey then rescinded the contract on November 15, 2015 to develop its own national missile defence system with the use of its domestic resources.

Following the decision, Turkey launched its own project to build a similar system and awarded an 18-month contract to Eurosam, Aselsan and Roketsan for a study into the development and production of a long-range air and missile defence system. The study agreement was signed on January 05, 2018 during a meeting between Turkish President Recep Tayyip ERDOĞAN and French President Emmanuel MACRON in Paris. The three-country feasibility study is expected to produce results in 24 months with potential joint production of an anti-ballistic missile defence system. Eurosam stated that the company offers the ASTER 30 Block 1NT as part of the joint development study which will assist Turkey’s indigenous air and missile defence system development program and strengthen the co-operation between the three countries.

With 30 years of experience in anti-air missile systems, the European manufacturer Eurosam participated

in IDEF 2019 this year and displayed its latest and most advanced missile defence solutions. In a time when the air defence needs of Turkey became a hot topic, we visited Eurosam's booth at the IDEF' 19 and had the chance to have a conservation with Eurosam Communication Manager - Mr. Eric DELEPOULLE about the company's current activities, capabilities of its products, and the ongoing joint Long-Range Air and Missile Defence Program contract which was signed between the Presidency of Defence Industries (SSB) and Eurosam last year.

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Mr. Eric DELEPOULLE - Eurosam Communication Manager

Stating that it is the 30th anniversary of Eurosam, Mr. DELEPOULLE said that "We are celebrating our 30th anniversary this year. Eurosam was established as a Franco-Italian joint venture between Thales, MBDA France, and MBDA Italy (Aerospatiale, Alenia, and Thomson-CSF) in 1989 to produce a new missile family with cooperation at the national level. Eurosam is the prime contractor and the design authority for the development, production, and sales of naval and ground-launched air-defence missile systems. Our products are currently in service of the Italian Army, Italian Navy, French Navy, French Air Force, and the Royal Navy. Included in the contract, Eurosam also provides maintenance services for five years to ensure the systems remain operational in the medium term."

Forming the cornerstone of Europe's naval and land-based air defence programs, the Development of ASTER missiles started in 1993 following a Memorandum of understanding signed between France and Italy for a family of future surface-to air-missiles. During the 1980s, the anti-air missiles in service of the French and Italian Armed Forces were short-range systems such as the French Crotale, Italian Aspide or American Sea Sparrow. In the early 90s, France and Italy decided to develop a domestic medium/long-range surface-to-air missile system with superior interception capability. The trials of the ASTER missiles were successfully completed in May 2001 and the system was deployed for the first time on the French nuclear-powered aircraft carrier Charles de Gaulle R91.

As a multi-national consortium, the development and initial production of Eurosam's air-defence systems were funded by the French and Italian MoD on a 50/50 basis. Emphasizing the joint development aspect of the ASTER Missile Family, Mr. DELEPOULLE stressed the importance of cooperation between France and Italy regarding the highly connected manufacturing process of the system. "Eurosam works on the system level, after that we rely on Thales and MBDA for providing modules. For example, the launcher is manufactured by MBDA Italy, the radar is provided by Thales and the missile is produced by MBDA France. The manufacturing process is quite complex and highly interconnected. Each module uses both French and Italian subsystems. The ARABEL radar is produced by French Thales but the IFF system belongs to the Italian Leonardo. Another example is the launchers are manufactured by MBDA Italy, but they have also French made subcomponents. It is a true joint project. As the ASTER missile system belongs to both countries, you can witness situations where Italian and French companies compete against each other with the same missile in defence procurement projects. In addition, there is an agreement at the political level between France and Italy regarding the exports to the third countries. Both countries share the same vision of interests and universal values so if one country agrees to sell the system, the other one follows. It is a matter of cooperation and compromise."

The ASTER missile family comprises ASTER 15 the short-medium range version and ASTER 30 the long-range version. There is an extensive commonality between the two variants with both missiles featuring the same missile body. ASTER 30 uses a much larger booster which increases its range and speed. ASTER Missile Family provide all-round anti-missile and anti-air protection and can intercept all types of air threats such as aircraft, UAVs, air-breathing targets, ballistic missiles, cruise missiles, and sea-skimming anti-ship missiles. ASTER 15 weights 310 kg and ASTER 30 weights 450 kg. ASTER 15 has a length of 4.2 meters while ASTER 30 has a length of 4.9 meters. Both missiles have a diameter of 180mm. The shot-range version, ASTER 15 has a maximum speed of Mach 3, a maximum range of 30 km and an interception altitude of 13 km. The long-range version, ASTER 30 can reach speeds of Mach 4.5 while reaching altitudes of 30 km with a maximum range of 120 km and can perform aerial maneuvers greater than 60 Gs giving it a very high degree of maneuverability. Highly maneuvering and agile ASTER missiles use a direct thrust vector control system called "PIF-PAF" which is intentionally located at the missile's center of gravity to maximize responsiveness to prevent ruptures under high-g maneuvers during trajectory corrections. During the flyout toward the target, ASTER can perform 90-degree trajectory changes. Both the ASTER 15 and the ASTER 30 missiles can be vertically launched from the ship based Sylver A50/A70 and American Mark 41 Vertical Launching Systems (VLS).

ASTER missiles are currently in service on board the latest naval vessels of France, Italy, and the United Kingdom. Equipped with an active RF seeker, the ASTER missile is autonomously guided and capable of simultaneously targeting and engaging multiple threats enabling it to counter saturated attacks. ASTER 15 and ASTER 30 missiles are integrated with the advanced Principal Anti Air Missile System (PAAMS-officially designated as Sea Viper by the Royal Navy) utilizing different types of C2 systems and multi-function radars on the British Type-45 destroyers and the Franco-Italian Horizon (Orizzonte) Class destroyers and FREMM frigates as well as the Charles De Gaulle and Conte Di Cavour aircraft carriers.

Mr. DELEPOULLE pointed out that these systems were developed to meet the operational requirements of modern air defence on the battlefield. Emphasizing that these requirements called for naval and ground-launched missiles capable of defeating threats as diverse as high-speed tactical missiles and highly-maneuvering aircraft in saturation attack scenarios, Mr. DELEPOULLE said: "The naval version of ASTER missiles is currently used onboard French and Italian air defence frigates as well as French aircraft carrier Charles de Gaulle and Italian aircraft carrier Cavour. SAMP/T, the ground-launched version of the system consists of three main modules. Each module has 8 missiles and a launcher that is connected to the main module with radio communication or fiber optic cables. We can connect 6 launchers to the system within a 10km radius to provide coverage for a wide area. The system is operated at the battalion level with C2 (Command-Control) structure through the data link or independently in autonomous mode. For target acquisition, the ASTER missiles are used in conjunction with the ARABEL radar which can detect Air-breathing Targets, Cruise Missiles, and TBMs up to 100km. The SAMP/T system can also be connected to the air defence network increasing its target detection range up to 600km. Each system consists of one C2 vehicle, one Radar, and 6 launchers. French and Italian Armed Forces operate one C2 vehicle, one radar, and four launchers per system. Because SAMP/T system uses only a single type of missile against all the threats, with 6 launchers up to 48 missiles can be fired against different targets to prevent massive air attacks."

X-Band Thales ARABEL Radar

In order to reduce operational and logistic costs, Eurosam systems are designed as common and interoperable building blocks according to the customer-specific requirements. The main building blocks include two multi-function radars (X-Band Thales ARABEL and C-Band MBDA Missile Systems EMPAR radars) and two missiles (MBDA Missile systems ASTER 15 and ASTER 30). Both missiles share the same missile body, featuring the patented PIF-PAF dynamic control system. The only difference is the size of their booster stages with varying maximum ranges from 30 km to beyond 100 km.

Mr. DELEPOULLE: "ASTER 30, the Long-Range Version Can be Used on Both Naval and Land Platforms for Area Air Defence."

Mr. DELEPOULLE emphasized the advantages of using one type of missile against various threats and shared information about the unique capabilities of the ASTER missiles in terms of logistics, training, and compatibility between different platforms. "There isn't any difference between the naval and ground-launched versions of the ASTER missile. Both Italy and France use the same missile on their naval platforms and land platforms. It is a great capability in terms of logistics and operational cost. As you know the U.S. utilizes different missile systems such as Standard Missile (SM) and Patriot for naval and land platforms. With ASTER, you can use one missile for various type of missions against all kinds of targets. This commonality provides other benefits as well. For example, the French Air Force provides training to the French Navy because they use the same missile. The naval version of the system requires some minor adjustments to the missile to use onboard naval platforms. However, these are only software changes that

Mr. Eric DELEPOULLE and Saffet UYANIK at IDEF' 19

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don't require physical modifications. Except for the trajectory software, it is the same missile. All versions of the ASTER family have the same missile body with two different boosters depending on the platform that the system deployed. ASTER 15, the short booster version is only used onboard the naval platforms for self-protection (point-defence) while the ASTER 30, the long-range version can be used on both naval and land platforms for area air defence."

According to Eurosam's statement, these sub-systems make up for systems that have outstanding effectiveness against saturating attacks inbound from all directions. Eurosam systems can operate either in stand-alone mode or interconnected with other weapon systems, thereby allowing their integration within a wider air defence network.

Underlining that network integration is one of the most important factors considering the performance of air defence systems, Mr. DELEPOULLE pointed out the highly accurate target acquisition technology of the system. "The given range of the ASTER 30 missile is beyond 100km. However, when we talk about the range of the missiles what really matters is actually the no escape zone of the target. The effective threat elimination range of the missile can vary depending on the type of the target and the detection distance. The point is, there are several factors that we must take into consideration when we talk about the range of the missiles. The radar, C2, and uplink capabilities of the user directly affect the performance of the system. The accuracy of the missiles is as important as the range of the missiles. The ASTER missile family has a special seeker with very high accuracy which provides the hit-to-kill capability. Although the missiles have directed fragmentation warhead, they can also use direct contact to eliminate hostile targets. the ASTER missile can use different methods to destroy threats, for example, it can neutralize TBMs or Cruise Missiles with its hit-to-kill capability or destroy hostile aircraft with proximity fragmentation. This allows the operators to use one type of missile against various targets. It absolutely provides a valuable capability considering the cost of each missile. During engagements, the system recommends different firing solutions based on the target and operational conditions. We normally recommend firing one missile per target. However, at the end of the day, it is up to the user to follow this recommendation or not. For example, the French Air Force prefers not to engage a single threat directly with two missiles."

SAMP/T batteries are at Kahramanmaraş

SAMP/T Systems Ready to Intercept! Its Readiness Level for the Battlefield Conditions is Only 25 Minutes

ASTER 30 has also been successfully incorporated into a land-based air-defence system, for the ground-based area defence mission requirements. The Eurosam SAMP/T (Surface-to-Air Missile Platform/ Terrain - Sol-Air Moyenne Portée/ Terrestre) system uses a network of sophisticated radars and sensors including an upgraded version of the long-range ARABEL 3D phased array radar with an improved performance developed under the ASTER 30 Block 1 upgrade program enabling it to be highly effective against all types of air threats. Thanks to its extended capabilities against higher speed and higher altitude targets, the system can intercept short-range ballistic missiles (SRBM) within a 600 km range.

Firing ASTER 30 by SAMP/T

In June 2016, Italy deployed a SAMP/T system to Kahramanmaraş Turkey as part of a NATO mission following a Turkish request to NATO on June 6, 2016, to further bolster Turkey's 900 km long border with Syria. The Italian Eurosam SAMP/T long-range air-defence unit was deployed to replace German Patriot batteries that were withdrawn in 2015. The SAMP/T batteries arrived at the Turkish port of Iskenderun on 5 June along with 25 Italian Army personnel. On July 4, 2019, the Italian parliament decided to extend the mandate of the Italian SAMP/T missile defence system deployed in Turkey's southeastern province of Kahramanmaraş until December 31, 2019.

Mr. DELEPOULLE also provided information about the operational capabilities of the Italian SAMP/T missile defence system currently deployed at Kahramanmaraş as part of a NATO mission to reinforce Turkey's border against a possible Syrian missile threat. "Two SAMP/T systems with ASTER 30 Block 1NT missiles are currently deployed in Kahamanmaraş for nearly 3 years. The operational readiness of the SAMPT system in Kahramanmaraş is currently at 95% and it is also connected to the NATO air defence and TBM defence network. The C2 module and launchers of the SAMP/T system have integrated power units and has a significantly shorter deployment time compared to the other similar systems. Because the system does not use trailers, it is highly mobile and can be deployed under 25 minutes in battlefield conditions."

As part of Turkey's efforts to develop a national long-range air and missile defence system the heads of Eurosam, Aselsan and Roketsan have

signed a Heads of Agreement (HoA) on July 14, 2017 in Ankara under the auspices of the Turkish Presidency of Defence Industries (SSB) to launch in-depth co-operation in the field of air and missile defence. Following this agreement, the Turkish, Italian and French defence ministers signed a Letter of Intent on November 8, 2017, to further strengthen their relationship in defence matters. The signature of these agreements showed the will of Turkish, French and Italian governments to cooperate on air and missile defence systems and was considered to be a strong token of Eurosam's dedication to using the SAMP/T as a solution for Turkey's air and missile defence requirements.

As a continuation of this process, on January 05, 2018, the SSB awarded Eurosam, Aselsan, and Roketsan a contract for the definition study of the future Turkish Long-Range Air and Missile Defence System. The study will define the future operational requirements of the Turkish Air Force and study the possibility of co-operation for the production of a long-range missile system, which will be based on the Aster 30 Block 1 NT (New Technology) missile. This cooperation between Eurosam and the SSB will also provide technology transfer to Turkey and bring the opportunity of export to third countries. The studies are planned to be finalized at the end of 2019. The signing of the contract for the definition study attracted a great deal of attention considering the agreement with Russia for the procurement of the S-400 system, which sparked tensions with the U.S. Government.

Regarding the ongoing process, Mr. DELEPOULLE informed us about the current situation of the joint-development program and Eurosam's stance on the co-operation with Turkey. "Because these systems have strategic importance the procurement of these systems are negotiated at the highest level. The first agreement between the SSB, Aselsan, Roketsan, and Eurosam for the 18-month definition study phase was signed at Elysee Palace in January 2018. The aim of this study is to determine Turkey's requirements for a long-range air and missile defence system. The contract was awarded by the SSB, which is responsible for the acquisitions as well as defining these requirements. As part of this process, Eurosam offers the ASTER 30 Block 1NT for co-production to meet the basic operational requirements of the Turkish Air Force. This joint development offer also aims to support Turkey's indigenous air and missile defence system development program in addition to opening new export opportunities and longer-term co-operation between the three countries. France and Italy are keen on offering our NATO ally the best product we are producing. The ASTER 30 Block 1NT is derived from the B1 missile and has a new seeker operating in Ka-band. This change brings a significant performance increase. The new missile will also be capable of intercepting MRBM (Medium Range Ballistic Missiles) threats and eliminating missiles with separable warheads. However, as I have mentioned before the missile is one thing and the air defence system is another thing. For Ballistic Missile Defence (BMD) capability you need a specific radar and C2 capabilities. That is the key point. Regarding the definition phase, we have been working closely with the SSB and the Turkish Air Force for 10 years. This definition study was a good opportunity to reinforce the relationship between Aselasn, Roketsan, and Eurosam because we are working as a team. We know our Turkish industrial counterparts and we know what to offer them. We are confident in what this co-operation will contribute, bringing our countries closer on a strategic level."

Turkey is a crucial and a formidable NATO member located between Europe and the Middle East, bordering Iraq, Syria, and Iran. Safeguarding the southeastern flank of the alliance with a standout armed force, Turkish national security is under constant threat from the conflicts in the region. For decades, as part of NATO Integrated Air and Missile Defence (NIAMD), Tukey relied on NATO partners to protect its territory especially against ballistic missiles. Currently, Spanish and Italian Patriot (PAC-2) and SAMP-T systems are deployed at Turkey's southwest border to defend Turkey from ballistic missile threats from Syria. However, these systems do not cover all of the 900 km long border with Syria. As a result, under constant threat from the adversary neighbors, Turkey has made considerable efforts to acquire foreign air and missile defence systems while also researching and developing

ASTER 30 Block 1NT

indigenous defence systems. With the beginning of the Syrian civil war and the cancellation of the Turkish Air Force Long Range Air and Missile Defence System (T-LORAMIDS) program, Turkey reprioritized the procurement of a long-range missile defence systems and decided to buy Russian S-400 systems which raised concern among other NATO member countries. Apart from the Russian S-400 deal, Turkey continued to work on a domestic missile defence program. A short time after the S-400 purchase, Turkey signed an agreement with Eurosam for a study about the possible joint development of a missile defence system. The feasibility agreement with Eurosam will not only contribute to the development of the domestic defence industry but also provide new opportunities for Turkey to market a product with high added value to the world. Carrying out studies on high altitude air defence systems for a long time, Turkey aims to develop indigenous air defence systems against aerial threats in the medium to long term with joint R&D studies. Thanks to this strategic step to improve the national defence industry, Turkey will also increase its contribution to the Alliance by investing in a system that will enhance NATO interoperability and strengthen the airspace of allied member states. If finalized, the Eurosam agreement will reinforce Turkey's position in the alliance by showing that Turkey is still committed to the security of its allies even while prioritizing its national security

Gökbey's Challenging Test Campaign Begins

by Cem AKALIN

The grueling test campaign of GÖKBEY will be conducted with three prototypes over the next two years. The first prototype – P1 soared at 6am with its much-anticipated debut flight June 29, 2019

The T625 Multi-Role Helicopter Program was initiated to cater to the light-weight class helicopter requirements both for military and private users worldwide. It was launched upon the decision of the Defence Industry Executive Committee dated on June 15th, 2010. The Turkish Light Class Utility Helicopter (TLUH) Program was signed between the SSB and Turkish Aerospace which was awarded the amount of US$687.3 million in a contract dated June 26th, 2013. On September 6th the contract became effective and the kick-off meeting was held on October 11th, 2013.

In conjunction with the contract effective date, the System Requirements on September 15th, 2015, Preliminary design on October 20th, 2016 and the Dynamic Systems Critical Design on December 28th, 2016 were completed according to the program schedule. The potential end-users (government agencies) submitted their requirements for this helicopter to Turkish Aerospace during this period.

The numerical name of T625 was designated for the platform that is comprised of the helicopter's six-ton gross weight, '2' representing the two engines and '5' representing the number of main rotor blades. In 2017, the first mock-up of the T625 Multi-Role Helicopter was debuted at IDEF' 17 held in May 2017. The first international demonstration was actualized at the Paris Air Show in June of 2017.

Test Campaign to be Completed Along with 3 Test Prototypes

Within the scope of the project, the Critical Design Phase was completed on September 29, 2017. As of October 2017, the first prototype design was finalized, and the manufacturing process was initiated by Turkish Aerospace. The Rotor System Test Preparation Review, as well as the first bladed engine run-up tests of the T625 Multi-role Helicopter prototype, was

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successfully completed between August 17th and 31st, 2018. The first hover flight of the T625 Multi-Role Helicopter for testing of the rotor system, engine, flight control, system and transmission were accomplished with the P0 prototype on September 6th, 2018 with the participation of an official delegation. The comprehensive test campaign was initiated by Turkish Aerospace following successful hover flight as of September 6th, 2018. The ground test activities and system verification tests forged ahead during this time period. According to Turkish Aerospace, it was carried out within 50 hours of system verification tests over the P0 prototype. Concurrently, the production of the P1 prototype was also completed during this period. As a result of these activities, the required structural retrofitting was reflected in the platform by Turkish Aerospace.

Within the scheduled program, 3 prototypes in total will be manufactured for the test campaign (flight and ground tests), system verification and optimization. To qualify for a particular type of certification, the helicopter must be in compliance with the 1956 safety requirements and successfully perform over a hundred helicopter and system level tests.

P1 Prototype has Accomplished its Maiden Flight on 29th June

On May 2st, 2019, Turkish Aerospace President & CEO Temel KOTİL said that "The production of the second prototype (P1) was completed recently. We are aiming for it to make its maiden flight within two weeks" during a press meeting at IDEF'19. Within the same month following this encouraging statement, the first bladed engine run-up of the second prototype (P1) fed by GPU (Ground Power Units) was successfully accomplished on May 20th, 2019. The first flight was expected to occur on June 18th, but the flight was postponed. On June 29th, the P1 Prototype successfully accomplished its debut flight early in the morning at 06:00am with the completion of the necessary permissions obtained from the General Directorate of Civil Aviation (SHGM). During this flight, the P1 climbed up to 50ft and ran around


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500 meters on a straight line, lasting a total duration of 45 minutes. With this flight, the GÖKBEY certification flights were officially launched.

The P1 prototype to be utilized in the flight and ground tests will incorporate the necessary system and structural retrofitting according to the verification tests over the P0 prototype. According to the test campaign schedule, the flight envelope's maximum speed, altitude and load factors will be expanded gradually with the P1 Prototype. Besides, more than 500 sensors mounted on the P1 fuselage, wings, main rotor mast, tail rotor, landing gears and different parts of the platform will relay critical information to the program system room, and all exceeded limits will be monitored in real-time and analyzed by the design team. The payload in particular and analytical data analysis to be collected during the ground and flight tests will be utilized for the optimization of the weight or the structural retrofit over the P3 prototype. Furthermore, the P2 prototype, which will support the P1 prototype during the tests, is still being manufactured at the facilities. According to Turkish Aerospace executives, the system integration of the P2 prototype is expected to be completed in August 2019 and is scheduled to enter into the test campaign in September 2019. Within the scope of the program, over 1500 hours of flight and ground tests are expected to be conducted with the prototypes. While the testing processes and the Technical Data Package are intended to be finalized in 2020, the type CS-29 certification and EASA certification processes are aimed to be completed in 2021. the T625 GÖKBEY is expected to be in service in 2021 according to the statement by Prof. İsmail DEMİR, during the Turkish Defense Industry Summit on December 13th, 2018,

The aircraft incorporates several new technology features to provide the highest levels of safety and operational advantages. Within the scope of the program, critical systems such as transmission, rotor, and landing gears as well as aerostructures and avionics systems are designed from scratch at Turkish Aerospace facilities in Ankara, Turkey.

A new generation, advanced aerodynamic indigenous rotor design will provide excellent performance in the most demanding operating environments. The T625 GÖKBEY design also benefits from extensive use of composites, advanced airframe aerodynamics, next-


© Turkish Aerospace

generation widescreen digital glass cockpit design and state-of-the-art avionics for maximum situational awareness.

Under the Turkish Light-Weight Utility Helicopter (TLUH) Program, Turkish Aerospace has completed design, development and manufacture of an indigenous twin-engine 5-ton class light utility helicopter with a takeoff weight of 6 tons and powered by two CTS800-4AT turboshaft engines, 1373shp each, enabling the aircraft to perform in hot & high environments and perform safely in a one engine loss condition for Category-A certification. The unique TS1400 Turboshaft engine, which is going to replace the CTS800-4AT in the serial production period, currently has been in development by TEI since 2017. The preliminary prototype of the turbojet core to be utilized on the TS1400 engine was successfully tested for the first time on a test bench on June 11, 2018. The SSB announced this success via its official twitter account; "Under our Turboshaft Engine Development Project, production of the preliminary prototype of the core motor which constitutes the main core of the TS1400 engine was completed and the first ignition test was successfully performed." The TS 1400 Turboshaft Engine development project consists of five stages which are as follows; the development of the core engine, prototype engine stage, mature engine stage, certificated engine stage and integrated engine stage. TEI is to design, develop, produce and certify two 1400shp turboshaft engine (TS1400, ITAR-free) prototypes.

The T625 GÖKBEY is designed for IFR and VFR single-pilot operations, night operations and flight in known icing conditions. The geometry of the helicopter is optimized for maximum aerodynamic performance with retractable landing gears hence providing efficient fuel consumption leading to better range and endurance. Thanks to the auxiliary fuel tank, the range of the helicopter surpasses the 950km range accompanied by five-hour endurance.

The T625 GÖKBEY has a five-blade main rotor and a four-blade tail rotor to minimize vibration and noise. Both the main and tail rotor hubs are fully articulated with elastomeric bearings. Both rotor systems are driven by a transmission system, which consists of the three-stage main gearbox, having the capability of operation for 30 minutes in the event of loss of lubrication. With regard to the main gearbox and tail rotor, Turkish Aerospace and Italian company Avio Aero signed an agreement for the manufacturing of several parts of the main gearboxes and tail rotor for the GÖKBEY at Paris Air Show' 19.

Aselsan's Modular Aviaonic Touch-Screen Environment

It also incorporates a state-of-the-art, four-axis, dual redundant automatic flight control system to improve helicopter stability, handling and reduce the pilot workload in-flight.

Aselsan's Modular Avionic Touch-Screen Environment (MATE)

The new generation smart cockpit of the T625 GÖKBEY and all its avionics systems were developed by Aselsan, demonstrating competitive and innovative solutions in the global aviation market with this new generation smart cockpit.

The new generation smart cockpit MATE (Modular Avionics Touchscreen Environment) consists of two wide touchscreen (8x20 inches) Integrated Mission Displays and two touch screen (8x10 inches) data entry Touch Command Control Units. MATE was developed to be compatible with the civil aviation standards of the European Aviation Safety Agency (EASA) and the General Directorate of Civil Aviation (SHGM) enabling pilots to control all avionics systems on the helicopter via the touchscreen cockpit displays. The navigation, communication, identification for friend or foe, electronic warfare and EO/IR systems of the helicopter were designed by Aselsan as well.

The T625 GÖKBEY Utility Helicopter's flight and mission management software was also developed by Aselsan. This software enables the helicopter to navigate Performance Based Navigation up to the level of RNP 0.3 (Required Navigation Performance 0.3) in all civil airspaces all over the world. The unique digital map and Helicopter Terrain Awareness and Warning System (HTWAS) software enables pilots to perform safe flights in extreme conditions.

The T625 GÖKBEY Helicopter is designed to offer a superior payload and diversified configurations to end-users. The T625 GÖKBEY can accommodate a maximum of two crew, namely a pilot and co-pilot, and up to 12 passengers. The extensive cabin space can also be customized according to the requirements of the end-user such as Search and Rescue, Passenger & Cargo Transportation, V.I.P., Firefighting, Air Ambulance, and Off-shore operations

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The three models (AW169, AW139, AW189) covering the 4.5-9-ton categories also demonstrate a similar approach in the cockpit layout and symbology. This provides unparalleled advantages for training with a 40% reduction in time for pilots moving from one type to another

Leonardo is a major force in delivering complete training solutions to its growing customer base worldwide. Leonardo has several Training Academies and Authorized Training Centers which allow for close customer proximity, they have trained over 10,000 students (crews and maintainers) from every continent across the globe and have logged more than 40,000 simulator flight hours in 2018. The company offers a comprehensive package of customized services designed in-house and the most modern and complete range of training rotorcraft. With a strong commitment to training as a key element for successful, effective and safe operations, and to create maximum return on customer investments, Leonardo provides its clients with services covering the full syllabus, from basic to advanced flight, from type certificates to recurrent, maintenance and mission training.

A total capability provider, Leonardo combines the best platform for the task, whatever the mission may be, with capabilities that allow pilots and technicians to maximize the effectiveness of their assets, to perform at their best and with the highest levels of safety and survivability, for operations over land and sea. Customers are offered digital training service solutions for distance learning across all geographies, dedicated classrooms at its Centers and Academies, virtual interactive procedural trainers to familiarize users with the cockpit layout and control, flight training devices of each helicopter type and Level D full flight simulators (a 1 hour flight is equal to 1 hour on the real aircraft, according to certification standards) developed with prime partners (such as CAE) or 100% in-house based on customer requirements, virtual maintenance trainers and full scale maintenance trainers. Pilots and cabin crews will receive the flight and mission training they need for their aircraft, configuration, mission profile and environment. Maintainers will be enabled to perform critical maintenance, repair and overhaul activities homeland or where aircraft are required to carry out their missions with the highest standard of quality, efficiency and safety. 24 hours, 7days a week real time distance assistance is provided to make sure error is not an option when on duty performing technical support. Additional services developed by Leonardo include Mission Planning Systems allow the crew to plan the mission, accounting for all key factors including risk assessment. Leonardo is also developing and testing an advanced stress monitoring system for the real time evaluation and analysis of crew stress and workload during flight and mission and of data collected via sensors in the cockpit. This would be highly beneficial for training in demanding operating conditions in order to maximize effectiveness, safety and survivability.

Helicopter types ideally suited for training purposes include the AW119 single engine and the AW109 Trekker light twin engine models.

Developed from the popular AW109 twin, the 2.8-ton AW119 is the best helicopter in the single engine category with best in class performance, cabin space, rugged airframe and multiple redundancies of all main critical systems, typically available on multiengine helicopters. Highly successful on the global market among military and parapublic operators for the widest spectrum of roles including training, utility, law enforcement, patrol, MEDEVAC/SAR, firefighting with more than 320 units on order, the mission purposed AW119 is the best of both worlds as it uniquely combines light twin performance and single engine economy. The latest variants (AW119Kx and TH-119) feature advanced digital avionics, also including synthetic vision for navigation in demanding conditions. The TH-119 is set to be the first single pilot IFR-certified single engine type in the world in nearly 40 years. The AW119 has also demonstrated 24,000 feet flying capabilities. Government operators, both NATO and non NATO, who have chosen the AW119 include, among others, the Portuguese Air Force (as a multipurpose aircraft also delivering training for crews before moving to frontline helicopters such as the AW101 long range SAR and the naval Super Lynx), the Finnish Border Guard and the Latvian Border Guard, the US, Chilean and Brazilian law enforcement agencies, the Ecuadorian Air Force, and operators in Africa and Asia.

The newest type in the Leonardo light twin range of bestselling AW109 products, designed to meet the widest scope of utility missions in the market is the AW109 Trekker which has already logged orders for over 60 units worldwide. The Trekker retains the AW109 Grand airframe, dynamics, outstanding performance and the largest cabin in the light twin class, while featuring all new digital avionics and, for the first time ever on an AW109, skids for operations on rugged and unprepared terrains and a stronger training and utility-oriented approach. The Trekker also boasts the best payload characteristics in the light twin segment and a highly competing unit price compared to its nearest contenders.

A distinguished and winning element that Leonardo products offer is strategy, the AW Family of new generation multipurpose dual-use helicopters (AW169, AW139, AW189) covering the 4.5-9-ton categories delivers unprecedented levels of versatility to the market and exceptional fleet management and cost/effectiveness. Sharing commonalities in terms of design and certification standards, performance and flying characteristics, maintenance equipment, the three models also demonstrate a similar approach in the cockpit layout and symbology. This provides unparalleled advantages for training with a 40% reduction in time for pilots moving from one type to another.

by İbrahim SÜNNETÇİ

Original Power System TS1400 Turboshaft Engine Developed by TEI's Seasoned Team of Experts for the T625 Helicopter

As a close follower of development and innovations in the field of aviation engines TUSAS Engine Industries Inc. (TEI) has accomplished important milestones in the initiatives toward developing the indigenous and national TS1400 Turboshaft Engine under the Turboshaft Engine Development Project since the first ignition of the Core Engine in June 2018. The TS1400 will power up the T625 GÖKBEY Turkish Light Utility Helicopter (TLUH) but it can also be integrated into the T129 Mk-I ATAK Helicopter with some adaptations. Being carried out by TEI's Seasoned Team of Expert Engineers, the TS1400 Turboshaft Engine Development Project is considered to be a giant step toward achieving the company's vision of becoming a "Globally Competitive, Original Power Systems OEM."

Under the TLUH Program TUSAS has completed the design, development and the manufacture of an indigenous twin-engine, 5-ton class medium category (4 to 6 tons), utility helicopter with a maximum take-off weight (MTOW) of 6,050 tons and powered by a pair of 1,400 shp class turboshaft engines.

Powered by a pair of LHTEC CTS800-4AT turboshaft engines, each generating 1,373 shp during take-off, the T625 TLUH first prototype (dubbed P0) performed its first flight, which lasted 20 minutes, on 6 September 2018 at 6:00am at TUSAS facilities in Ankara. According to Honeywell the CTS800-4AT has almost 95% commonality with CTS800-4A engine, which is being used on T129 Mk-I ATAK helicopters and the 5% difference stems from necessary modifications on the engine and FADEC system (Full Authority Digital Engine Control) System to meet the T625 specific requirements.

Under the Prototype Phase, Turkish Aerospace will manufacture four prototypes for flight and ground tests, and to power these helicopters 10 CTS800-4AT turboshaft engines have been ordered from the Light Helicopter Turbine Engine Company (LHTEC, a 50-50 partnership between Honeywell and Rolls-Royce) under a contract signed on 10 December 2015 between TUSAS and LHTEC. According to Honeywell, as of May 2019 six of these 10 CTS800-4AT engines have already been delivered and the remaining four engines

(expected to be used as spares and for ground testing purposes) are scheduled to be delivered during 2019.

The T625 GÖKBEY TLUH will initially be certified by Turkish Directorate General of Civil aviation (SHGM) & European Aviation Safety Authority (EASA) and then converted with the installation of related mission equipment for Turkish military use to replace the aging AB-205s and UH-1H Hueys. A military version of the T625 GÖKBEY will follow about two years after the first flight. Certification and qualification efforts have been started in 2018 and scheduled to be completed in 2020. Serial production of T625 GÖKBEY TLUH is also expected to start in 2021.

The production of T625 GÖKBEY helicopters are initially expected to be powered by a pair of LHTEC CTS800-4AT turboshaft engines, but once all tests are complete and the required certification is obtained, the serially produced T625 GÖKBEY helicopters will start flying with indigenous TS1400 engines (in 2024-2025 timeframe), which are being developed domestically by TUSAS Engine Industries Inc. (TEI) under the Turboshaft Engine Development Project (TEDP). The TS1400 Turboshaft Engine can also be integrated into the T129 Mk-I ATAK Helicopter with some adaptations.

On February 7, 2017 TEI was awarded a contract by the SSB under the Turboshaft Engine Development Project to develop Turkey's first indigenous turboshaft engine to power the T625 GÖKBEY TLUH. Under the eight-year (2 years for the development of the

turbojet core + 4.5-years for the prototype manufacture + 1.5 years for certification) schedule TEI is to design, develop, produce and certify two 1,400 shp turboshaft engines (TS1400, ITAR-free) prototypes with a team of 250 engineers. The preliminary prototype of the turbojet core to be used on the TS1400 engine which was successfully tested for the first time on a test bench on 11 June 2018. The test cell, where the TS1400 Core Engine Tests are being conducted, was designed, manufactured and made ready for use with fully domestic achievement in cooperation with the 1st Air Maintenance Factory Directorate and TEI.

According to the information we have obtained, 12 to 14 TS1400 prototypes will be produced by TEI under the 8-year Turboshaft Engine Development Project including the core engine prototypes.

During the Concept Development Phase of the TEI TS1400 Engine, 10 different engine models were examined and the centrifugal (radial) flow compressor design, which is more suitable for the turbocharger, was adopted. Axial compressors, on the other hand, are generally preferred for turbojet engine designs. For example, the Kale ArGe Company product KTJ-3200 Engine, and the French Safran Power Units' (formerly Microturbo) TR-40 Turbojet Engine features four-stage axial compressors. With the centrifugal design, higher mass flow rates can be obtained in narrower spaces (shorter engine length), however, the centrifugal compressor design requires larger engine diameter than the axial compressor design. The axial flow compressor engines are smaller in diameter, but they are notably longer. Centrifugal compressor engines are considered more robust and stable, while engines with axial compressors are more fuel-efficient than the centrifugal compressor engines. Since the aim of the TS1400 design is to develop a turboshaft engine rather than a turbojet engine, a centrifugal flow compressor design was chosen because the shaft power is more important than the propulsive power (thrust).

The TS1400 Engine consists of a two-stage Centrifugal/Radial

Compressor, a Reverse-Flow Combustion Chamber (Combustor), a two-stage High-Pressure Turbine (HPT) and a two-stage Power Turbine (PT). The 2nd core engine prototype in turbojet configuration, which was previously exhibited at IDEF 2019 as well as at the Istanbul Air Show (AIREX) and at the 4th High-Tech Port by MUSIAD in 2018, has an exhaust vent at the rear section instead of a Power Turbine. Power Turbines are required for the transition of the core engine in turbojet configuration to both turboshaft and turboprop configuration.

The turboprop version of the TS1400 Turboshaft Engine is planned to power TUSAS HURKUS-B/C aircraft. In the turbojet configuration of the TS1400, the core engine can also be converted to turbofan configuration by adding a fan and additional shafts and bearings to the front side and a power turbine to the rear side. Turbofan engines have 30% to 40% lower fuel consumption rates compared to the turbojet engines; however, their production is more difficult, and their unit costs are more expensive than turbojet engines. For example, the unit price of an F107-WR-402 turbofan engine is US$190,000, while the unit price of a turbojet engine in similar class/thrust rates is around US$100,000.

Among the main purposes of the Turboshaft Engine Development Project (TEDP) is the establishment of a gas turbine engine design and the development of infrastructure and the knowledge to facilitate such a development process. Thus, the core technology of the TS1400 Engine shall also form the basis for the indigenous turbofan engine (in 8,500lbf to 9,500lbf thrust class) needed for the HURJET New Generation Advanced Jet Trainer (AJT) & the Light Attack Aircraft Development Project, and it will be possible to develop the national aircraft engine when needed, upon any necessary technological additions to the capabilities gained under the TEDP.

However, the TS1400 engine, which prefers a two-stage centrifugal compressor like the LHTEC CTS800-4AT engine with a high-level weight and volume optimization, requires axial (front) air intake assembly changes that are necessary for a turbofan engine design. Although extremely suitable for turboprop (TP) or turboshaft (TS) engines, the two-stage centrifugal compressor architecture has some disadvantages in terms of the cross-sectional area due to both the bypass ratio (the ratio of the air that goes through the core, i.e. the capacity) as well as the placement of the radial air assembly and the combustion chamber. The TS1400 is anticipated to be developed further with a multi-stage axial flow compressor and then a single-stage centrifugal compressor assembly to be able to evolve into a high-performance, low-thrust turbofan (TF) engine. Announced by TUSAS General Manager Dr. Temel KOTİL during the IDEF '19 Fair for the first time, the indigenous 2,500-3,000 shp turboshaft engine, which will power the T129 Mk-II (ATAK-II) Heavy Attack Helicopters, can be expected in a similar configuration.

According to TEI, the TS1400 Engine has a more robust design thanks to the centrifugal compressor assembly. It allows the air to flow through the core from front to top, not from front to back, creating more efficient

negative and positive pressures. Under the TEDP, TEI has been able to effectively produce TS1400 core engine prototypes within two years following the contract and plans to perform the first flight test on the T625 GÖKBEY helicopter in 2021.

Although the contract was signed in February 2017, the history of TEI's knowledge and infrastructure accumulation for the TS1400 engine goes back to the Core Engine Technology Development Project that was launched in July 2012 with a 3-year schedule. The aim of the project was to develop core engine technology, which would form the basis for a 1,000 hp class turboshaft engine. Under the project, conceptual design software & methodologies for the indigenous compressor, combustion chamber, and turbine were developed by studying different engine architectural concepts. The detailed design studies on the TS1400 started in 2016. The oil lubricated TS1400 engine also features an indigenous FADEC System. The two TS1400 engines on the T625 GÖKBEY will be able to communicate with each other via FADEC. For example, if an engine experiences power loss during the flight, the other engine will be able to increase its power to compensate the lost power of the other engine. The standard engine power of the TS1400 will be 1,400 shp (shaft horsepower) but it will also have the capacity to produce 1,660 shp for a period of 30 seconds in an emergency, such as in the case of the loss of another engine.

The TEI TS1400 engine is expected to have similar dimensions and weight with the LHTEC CTS800-4A/4AT Turboshaft Engines, which have a reputation for compactness, light weight, reliability, power and durability. In open sources, the dry weight of the LHTEC CTS800-4A Engine (with a length of 86,4 cm and height of 72,9 cm) is stated to be 360 lbs. (163 kg). According to the EASA Type Certification Data Sheet the CTS800-4N version, featuring a reduction gearbox compared to the CTS800-4A/AT versions, with an overall length of 122,2 cm overall width of 60 cm and overall height of 72,9 cm has a dry weight of 408 lbs (185,1 kg). The TS1400 Engine will ensure the shaft output speed conditions of 23,000 rpm and have a service ceiling of 20,000 ft. The process which starts from the engine right through to shutting it off again is known as a cycle, and over the engine's lifetime there are only a finite number of cycles before something cracks or breaks. The conventional methodology for measuring this lifespan and one that's used by many engine manufacturers is known as the TAC (Total Accumulated Cycles). One TAC is the equivalent of one cycle of an engine (exactly: one excursion from engine start, passing intermediate power rating and back to engine stop). The average lifespan of the TS1400 is expected to be at least 2,500 cycles, while the target for the service life is 5,000 cycles (TAC). After 2,500 or 5,000 cycles the TS1400 will require a general overhaul.

TS 1400 Turboshaft Core Engine

A team of approximately 250 engineers, all of whom are TEI employees from TEI's Eskişehir, Ankara and Istanbul Engineering Offices, are involved in the project. The TS1400 turboshaft engine design team includes engineers from the fields of Aerothermal Engineering, Structural Engineering, Product Engineering, Prototype Testing, Electrical/Electronic & Control Engineering, and Embedded Systems Engineering.

TS 1400 for T129 Mk-I ATAK Helicopters

The TEI TS1400 Turboshaft Engine can also be integrated into T129 Mk-I ATAK Helicopter with some adaptations to replace LHTEC CTS800-4A Engines for which Turkey has been experiencing difficulties for several years in obtaining an export license from the U.S. Government. In 2015 Turkey had finalized negotiations with Turkmenistan for the sale of 2 T129 Mk-I ATAK Helicopters however since the U.S. Government did not provide the export license for the LHTEC CTS800-4A Engines this project was not realized. A similar problem is being experienced for the sale of the T129 Mk-Is to

TS1400 Turboshaft Engine Specifications	
Sea Level Standard Air Max. Take-off Power	1,400 shp
Sea Level Standard Air Max. Single Engine (30 sec) Power	1,660 shp
Max. Power-to-Weight Ratio	8,54 shp/kg
Service Ceiling	20,000 ft
Output Shaft Speed	23,000 rpm (28,000 rpm reached during the test at a test cell)

Pakistan. Turkey has been waiting for more than a year for the U.S. export license in order to proceed with the Pakistan T129B Mk-I deal.

The contract for the sale of 30 T129B Mk-I ATAK Light Attack and Tactical Reconnaissance Helicopters to Pakistan Land Forces was signed on 16 May 2018, yet it has not become effective as of June 2019. Official application to the U.S. Government regarding the export license of the LHTEC CTS800-4A Turboshaft Engine utilized on the helicopter was made, the process was completed with the Foreign Affairs Commission and the request was submitted to the U.S. Department of Defence. The approval process was still underway as of May 2019. Turkish Aerospace previously received the Original License Document from the U.S. Government for the sale/export of the T129B to Pakistan. The Philippine Air Force is another customer for the T129B Mk-I Helicopter. On 18 December 2018, a MoU for Defence Industrial Cooperation between Turkey and the Philippines was signed between the SSB's Prof. Ismail DEMIR and Philippine Secretary of National Defence Delfin N. LORENZANA at Villamor Air Base in Manila. This MoU will pave the way for cooperation between the two countries in the field of the defence industry and the sale of the Turkish Defence and Aerospace Industry products (including the T129) to the Philippines. The Philippine Air Force will procure 6 (+10 optional) T129 Mk-I Helicopters if the necessary export license for the T129B Mk-I will be received from the U. S. Government.

Even though negative feedback is not expected from the U.S. Government regarding the export license of the CTS800-4A Turboshaft Engine, negotiations with the French Safran Group are being conducted on alternative engine options as a Plan-B. The Safran Helicopter Engine currently has two turboshaft engines which are 1,400 shp class, for twin-engine helicopters in its product portfolio and the company plans to get EASA certification for both of them in 2019. The Ardiden 1H1/Shakti, which powers the twin-engine Dhruv and LCH (Light Combat Helicopter) from India's Hindustan Aeronautics Limited (HAL) is designed to produce 1,430 shp. With a power range of 1,100 shp to 1,400 shp the Arrano 1A Turboshaft Engine was selected by Airbus Helicopters in early 2015, as sole engine for its new twin-engine helicopter H160, in part, on its ability to deliver extra power when operating in hot-and-high conditions. The Arrano 1A has a dry weight of over 300 kg and features a two-stage Centrifugal Compressor, Reverse-Flow Combustion Chamber, Variable Inlet Guided Vanes, 4th Generation FADEC and a 3D-Printed Fuel Injector. According to Safran Helicopter Engines, depending on the mission, the Arrano 1A Engine can fly almost 5,000 hours before needing a general overhaul (Depot Level Maintenance). Since its first ground test in February 2014, more than 10 test engines have been running at Bordes (France) to demonstrate engine performance. The Arrano-powered H160 (PT2 prototype) made its first flight on 27 January 2016. As of February 2019, the Arrano 1A Engines accumulated more than 7,000 test hours, including 1,100 hours in flight.

Previously, within the scope of the tender that was launched by the SSB in 2014 to meet the engine

Safran's Arrona1A Engine

requirement of the TLUH (both civil and military versions) prototypes, Turbomeca (now Safran Helicopter Engines) competed with LHTEC and had proposed the Arrano Engine. At that time the company had underlined that it was designed for both civil and military rotorcraft and that the Arrano Engine was 100 % ITAR Free and would be civil certified. At that time civil certification (EASA) for the Arrano Engine was planned to be obtained in 2017. Yet, the winner of the tender, which was finalized in April 2015, was LHTEC with their CTS800-4AT Engine.

The Benchmark of T625 GÖKBEY & H160

The T625 GÖKBEY shares several similarities with Airbus Helicopters' H160 Helicopter. Both of them are medium weight, in twin-engine configuration (powered by a pair of 1,400 shp class turboshafts) utility helicopters and will both have civil and military versions.

The H160 Program of the Airbus Helicopters was launched at Heli Expo in 2015 under the prototype name X6. Airbus Helicopters currently operate three dedicated prototypes (PT1, PT2 and PT3) and two helicopter zero integration test means under the H160 Program and plans to obtain EASA certification by the end of 2019 with an expectation to start deliveries to their launch customer, Babcock, in 2020. About 1,500 flight hours will likely be recorded by the time the aircraft is certified by the EASA. Airbus Helicopters secured 15 sales of this type in 2018.

The H160 has a Fenestron shrouded tail rotor and is powered by twin Safran Helicopter Engines Arrano 1A turboshafts. As of February 2019, the three flight-test prototypes have accumulated over 1,100 hours in the air including customer demonstrations. The first flight-test prototype (PT1) performed its 40-minute maiden flight on 13 June 2015, powered by a pair of Arrano 1A Engines. The second prototype (PT2), which performed its first ground run on 18 December 2015, joined the flight test program on 26 January 2016. The third H160 prototype (PT3) performed its maiden flight in October 2017. The first serially produced H160, which made its first flight in December 2018, was deployed to Northern Finland in February 2019 for cold-weather tests.

The H160 will have a certified mass of 5,670 kg (12,500 lbs.) for take-off but a flight manual supplement has been drafted to allow operators who wish to have a maximum takeoff weight of 6,050 kg (13,338 lbs.) without significant operational limitations.

While the military version of the H160 — the H160M — has been chosen as the platform for the French military's tri-service Joint Light Helicopter (Hélicoptère Interarmées Léger/HIL) Program, which has an initial requirement for 169 helicopters (80 for the Army, 49 for the Navy, and 40 for the Air Force). On May 2019 the H160M was designated as Guépard (Cheetah) and French Minister of the Armed Forces, Florence PARLY, announced that the launch of the HIL Program has been brought forward to 2021. Under the HIL Program, for which Airbus Helicopters' H160M was selected in 2017, was initially scheduled for launch in 2022. The H160M Guépard Helicopter will enter French military service in 2026. The full-scale mock-up of the H160M Helicopter was presented at the French Ministry of the Armed Forces stand at the Paris Air Show 2019. The H160M will replace 5 legacy types (Fennec, Gazelle, Dauphin/Panther, Lynx and Puma/Super Puma) in the French Army (to replace Fennec, Gazelle and Puma), Navy (to replace Dauphin, Panther and Lynx) and Air Force (to replace Fennec and Super Puma). The H160M can carry 5 fully equipped commandos in addition to 2 pilots and in SAR configuration 2 stretchers and 5 passengers in addition to 2 pilots

The Benchmark of T625 GÖKBEY & H160

	T625 GÖKBEY	H 160
Max Cruise Speed	306 km/hr	277,8 km/hr
Length (Rotors Turning)	15,87 m	15,7 m
Main Rotor Diameter	13,20 m	12 m
MTOW	6,050 kg	5,670kg extended gross weight 6,050 kg
Crew	2	2
Passengers	12	12
Standard Fuel Tank Capacity	1,020 kg	1,120 kg
Auxiliary Fuel Tank Capacity	280 kg	500 kg
Cargo Bay Volume	1,1 m^3	
Service Ceiling	6,096 m	5,900 m
Range	740+ km / (948+ km*)	796 km
Endurance	3,8+ hr / 5+hr*	4,2 hr
Powerplant	2 x LHTEC CTS800-4AT & TEI TS1400	2 x Arrano 1A Turboshaft Engine

*With auxiliary fuel tank

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CLARION EVENTS

Addressing UAVs and Anti-Drone Technology with a Multi-Pronged Response

by Saffet UYANIK

Anti-drone technology, also known as counter-UAV or C-UAS technology, refers to systems that are used to detect and neutralize unmanned aerial vehicles. As concerns grow around the potential security threats that drones may pose to both civilian and military infrastructure, a promising new market for anti-drone technology has emerged

Unmanned Aerial Vehicles (UAVs), or commonly known as drones, are aircraft without a human pilot on board. The introduction of UAVs has been one of the most significant technological advances in recent years. The capabilities and availability of UAVs are developing quickly and they now present both challenges and opportunities. Drones are now being used widely due to their availability, ease of use and low cost. While their widespread use and popularity bring benefits to certain industries, drones also pose significant risks to aviation, public security, and military operations. As drones become more common in the skies, so too do incidents. Aircraft collisions are increasing dramatically while terrorist organizations are exploiting the accessibility that they offer.

With the Syrian Civil War, numerous state and non-state actors have had the opportunity to test new weapon systems under battlefield conditions and learn operational concepts and tactics. The current hybrid warfare environment with state proxies introduced new asymmetrical capabilities that challenge the established superiority of conventional armed forces. As an emerging threat, drones are now used by various armed groups on the battlefield where they are deployed almost daily to carry out covert and unprecedented attacks. While solutions to counter this threat are also introduced, according to the reports published by the Center for the Study of the Drone, there is a wide variance in the effectiveness and reliability of counter-drone systems. To mitigate danger from drones, a multi-pronged response is required, including appropriate rules and regulations combined with technological solutions as well as a prudential shift in law enforcement's approach to unmanned aerial systems.

Serious Risk of Collision

Since drone prices have become more affordable, drone sightings near airports have been on the rise for years, as have the reports of drone near misses with aircraft. At least seven collisions have been reported between aircraft and drones worldwide. It has become an especially serious issue in the United States with around 100 reports per month. A majority of the incidents occur within 8 km of the airport, which is prohibited airspace for drones.

According to the Directorate General of Civil Aviation, the number of UAV pilots in our country has increased to 35 thousand, and the number of UAVs has increased to 27 thousand as of the end of last year. In just one year, 7,000 more UAVs were registered to the General Directorate of Civil Aviation (DGCA), while the number of UAV pilots increased by 13,000 with record growth. As a result of this increase in the number of UAVs and drone users, the DGCA has prepared a draft regulation that reorganizes UAV instructions. One of the most important changes in this legislative amendment is the introduction of the UAV operator definition, as in the case of airlines, so that companies that meet the necessary requirements can become UAV operators. Another important change is the removal of the definitions of uncrowded, crowded, and overcrowded areas and replacing them with green, restricted (red), permit-required, and no-fly zone definitions.

Drones Lead to Serious Airport Traffic Disruption

Commercial drones have started to cause a significant amount of disturbance at airports in recent years. They pose an extreme safety risk to passenger jets and disrupt airports by forcing airlines to suspend flight operations. In late December 2018, the second largest airport in the UK, Gatwick Airport near London, England was shut down after three days of drone sightings. The reports caused major disruption, affecting 1,000 flights carrying approximately 140,000 passengers at an estimated cost of over £50 Million over the course of 36 hours. Authorities regained the control of Gatwick airport only after the British army deployed an Israeli-built Drone Dome defence system and the flights resumed three days later. To protect themselves from future incidents, both Gatwick and Heathrow airports confirmed that they have acquired and installed their own anti-drone systems.

Cause for Considerable Concern

Unfortunately, drones are emerging as a cheap and effective way to deliver a variety of physical threats. It is a very well-known fact that various terrorist groups use drones during their attacks. The new drone systems have become smarter in recent years with the development of various technologies, accelerating the work on anti-drone systems. Defending civilian infrastructure differs from that of military facilities. Drones can now be pre-programmed with GPS coordinates allowing the device to automatically move to their destination without user input during flight.

Drones are preferred by terrorist organizations due to their low cost, speed, maneuverability, payload capacity, and risk-free advantages. They have become a serious threat for critical plants such as nuclear power plants, stadiums or airports. Although there hasn't been a tragic incident so far, the fact that drones strengthen the psychological effects of terrorism makes the issue even more sensitive. As the popularity of drones increase, it will be easier to obtain them, causing greater risks to both safety and security. The widespread availability of drones and the potential danger of this situation is one of the most important reasons for the development of anti-drone systems.

In Syria and Iraq, the ISIS terrorist organization operated a wide variety of drones to carry out coordinated attacks. ISIS' ability to operate small UAVs dramatically changed the balance of capabilities between the terrorist group and the U.S. led Coalition forces. In October 2016 the terrorist group used unmanned aerial systems armed with explosive ordnance to conduct numerous attacks against tactical and strategically important targets by dropping grenades and small bombs on groups of soldiers, vehicles, and buildings. The group carried out more than 200 such attacks in 2017 alone. Parallel to the developments in UAV systems, ISIS also used drones at the tactical

and operational level to provide reconnaissance-surveillance-intelligence and to guide their militants and vehicle-borne IEDs (SVBIED) more accurately toward their targets.

Related to the ongoing conflicts in Syria, on 5-6 January 2018 Al-Nusra Front militants carried out a drone swarm attack against Khmeimim and Tartus bases used by the Russian Federation Armed Forces. As the first of this kind in the history of warfare, this particular attack was quite significant as it demonstrated the threat level that UAVs can easily reach. According to the statement by the Russian Ministry of Defence, 13 fixed-wing drones, each armed with ten pieces of improvised explosive devices (IED) weighing approximately 400 grams, were involved in the attack. The effective radius of the ordnance was stated to be 50m. Militants targeted the Khmeimim Air Base with 10 UAVs and Tartus Naval Base with 3 UAVs. It was also reported that another UAV equipped with camera systems was also used for damage assessments and firing adjustments. The presence of a surveillance drone may indicate the tactical command-control capabilities of the militants in coordinating the drone attack in real-time. Head of the Russian General Staff's Office for UAV Development Major General Alexander NOVIKOV stated that six of 13 drones had been neutralized by electronic warfare systems and the remaining seven were shot down by the Pantsir S-2 air defence system. The improved version of the earlier Pantsir S-1, Pantsir S-2 is armed with two very high rate-of-fire 2A38M 30mm automatic anti-aircraft guns derived from the GSh-30 twin-barrel 30mm aircraft-mounted cannon. The Pantsir S-2 also carries the new highly capable 57E6-E guided surface to air missile.

Since 2015, Yemen's government has been in a civil war against the Houthi movement that originated in Northern Yemen. Part of a larger regional conflict between Saudi Arabia and Iran, this controversial conflict has caused considerable casualties and a famine that's killed an estimated 50,000 people. The US

government has also been involved in the conflict, supplying weapons to the Saudi-led coalition against the Houthi rebels. The Iran-aligned Houthis have launched a series of drone attacks since early 2018. In July, Houthis carried out an attack against Saudi Aramco oil refinery in Riyadh with armed drones and another one against the international airport in the UAE. On January 10, 2019, the Iranian-backed group conducted a targeted attack with a bomb-laden drone, killing at least 6 members of the Saudi-backed Yemeni forces gathered at an army parade near the al-Anad airbase, including a number of senior Yemeni military officers as well as military intelligence head Maj. Gen. Mohammad Saleh TAMAH.

The most important factor in Houthi drone attacks is that these actions have a versatile and holistic profile. Considering the Iranian connection, the use of drones by these irregular forces can be considered as part of the proxy war concept. The ballistic missile attacks adopted by the Houthi militants with the possible technical assistance of Iran have had devastating results for the Saudi-led Coalition, causing more than 100 casualties. Within this context, the Houthis launched a series of drone strikes against MIM-104 Patriot PAC-3 air defence systems located in the central Yemeni province of Ma'rib in February 2018 with Qasef-1 drones, and the Najran Regional Airport in southern Saudi Arabia in May 2019 using Qasef-2K drones. According to a report of the Conflict Armament Research (CAR) group, the Qasef family of drones are near-identical copies of the Iranian-made Ababil-2 UAVs which can carry a 30kg warhead.

In summary, the acquisition of UAV capabilities of non-state actors is a serious matter that needs to be addressed in the very near future. Because terrorist organizations employ the majority of their platforms in a kamikaze type of attack, it is critical to prevent these organizations from establishing a supply chain that is essential for operational continuity. Furthermore, not relying on a single system and using combined elements such as electronic warfare and various air defence systems together, to

counter the drone threat as in the case of the Russian approach against the drone swarm attacks, will become increasingly important.

Countering the Threat

The number of anti-drone systems has increased dramatically in recent years as a result of drone-related threats against critical facilities and civil aviation. Conventional air defence systems designed to counter manned air platforms cannot provide efficient results against unmanned systems. Since air defence systems are generally designed against large aerial platforms, they could be ineffective at detecting drones with a much smaller radar cross-section (RCS) at long distances. Furthermore, developing low-cost solutions is one of the most important requirements when designing dedicated systems to counter UAV threat, unlike conventional air defence systems.

According to the CSD Counter Drone Systems Report published by the Center for the Study of the Drone at Bard College in February 2018, there are currently 235 anti-drone solutions sold by 155 companies from 33 different countries. The AUDS consortium (Blighter Surveillance Systems, Chess Dynamics and Enterprise Control Systems) product counter-UAS defence system, IMI Systems (Israeli Military Industries) product Red Sky Drone Defender system and Israeli RAFAEL Advanced Defence Systems product Drone Dome system which was reportedly used at Gatwick Airport, are among the most capable anti-UAV systems available worldwide.

The development of anti-UAV systems is directly related to the characteristics of the areas where such systems will be used. In residential areas and metropolises, anti-UAV systems are frequently used to protect centers with a high concentration of civilians and critical facilities against terrorist threats. Anti-UAV systems to be used in rural areas and residential areas can have significant differences between them. This situation creates numerous challenges for the use of these systems in important locations with a potential threat.

Anti-drone systems utilize different types of technologies such as Radar, RF Scanners, Acoustic Sensors, and Electro-Optical Thermal/IR Cameras to detect mini and micro UAVs. Anti-Drone systems employ radars as their primary detection technology. Special radars capable of operating in all weather conditions are used to detect low-flying UAVs and differentiate them from other aerial platforms and birds.

As a passive detection method, RF scanners can detect drones by scanning their frequency bands. The operating principle of RF scanners is similar to that of radars but differs

from them by using passive detection technology. Anti-drone systems can also be integrated with acoustic sensors that can detect drones from engine and propeller noise. To identify and classify drones detected by these active (Radar) or passive (RF, acoustic) techniques, anti-drone systems use electro-optical camera systems that can detect UAVs with day/night or infrared (IR) sensors. Since the technologies alone are not effective in detecting all different types of UAV threats as standalone systems, existing anti-drone systems use these methods in an integrated way. Moreover, artificial intelligence can also be used for the identification and classification of UAVs.

Anti-drone systems use a combination of different techniques which can be grouped as kinetic and non-kinetic to eliminate threats. Non-kinetic solutions intercept the drones without directly damaging the device by interfering with the communications signals that drones rely on for guidance and control. Non-kinetic solutions include technologies such as RF jammers, GPS jamming, and Spoofing. As the most commonly used method, RF Jammers neutralize UAVs by disrupting their radio transmission or satellite communication signals used for navigation. The disconnected drones either proceed to land on their current position or return to their take-off point. RF Jammers are also capable of blocking the audio and video feed transmitted from UAVs. However, this method is ineffective against autonomous systems as they do not rely on a permanent connection with their users. Along with GPS jamming and Spoofing, RF jamming is the most widely used method by anti-drone systems today. GPS jamming refers to deceiving GPS-capable devices by broadcasting false GPS signals relaying incorrect geo-location coordinates. Spoofing, also known as protocol manipulation, is used against UAVs to take control of the targeted drones by hijacking their command-control or satellite/navigation communication.

However, one major drawback of RF jammers is the level of precision required to jam drone signals while not interfering with other frequencies. RF jammers must be continuously pointed at the drones to work as intended. Another problem is, RF jammers cannot counter specific radio signals but a range of frequencies (typically from 2.4 to 5.0 MHZ) which means that any communication device operating in the jammer's frequency range would also be disrupted.

Aselsan's ATOM 40mm Anti-Drone System and Laser Defence System

Kinetic solutions or commonly known as "hard kill" measures use physical force to neutralize and render drones inoperable. One of the primary advantages of kinetic solutions is that they work against UAVs, which follow pre-programmed GPS coordinates without relying on RF, WiFi, or other communication protocols. The most prominent methods for countering UAVs with kinetic capabilities include projectiles, rockets, and laser systems. Certain anti-drone systems such as the AUDS consortium Counter-UAS Defence System (Kongsberg XM-153 CROWS II M134 Weapon Adapter Kit) or the Aselsan IHTAR Anti-Drone System (Aselsan SARP RWS fitted with 40 mm MK19 Mod3 AGL using ATOM Air Burst Munition) can be combined with Remote Controlled Weapon Stations to provide a high-volume of destructive firepower against UAVs. Although this method is generally considered more primitive, it provides better results than other solutions. Recently, anti-drone system producers have also started to demonstrate their solutions to neutralize drones with laser weapons. The U.S. defence giants Raytheon and Boeing, as well as German Rheinmetall and MBDA Deutschland have been heavily investing in directed energy weapon systems. All the companies are currently developing High Energy Laser (HEL) weapon systems against aerial threats, including UAVs. Turkish defence industry companies Aselsan (LSS - Laser Defence System) and Roketsan (ALKA YESS) have also

Roketsan ALKA YESS was displayed at IDEF'19

The eagles of Guard from Company grappling the drone

introduced their own directed energy systems. Lasers are considered as part of kinetic interdiction methods because they directly damage or destroy drones. Directed energy weapons have become the preferred choice of militaries around the world for future implementations as this capability can be especially effective against small, fast, and agile UAVs. The most obvious disadvantage of kinetic counter-drone solutions is that they pose a significant risk of collateral damage. Kinetic solutions rely on physically damaging or disabling drones and rendering them inoperable. Once a drone is knocked out of the sky, it simply falls down endangering people or critical infrastructure that may happen to be below it. Therefore, using kinetic solutions in heavily populated areas or sensitive facilities creates a serious safety risk.

Another method that Anti-Drone systems employ against UAVs is to disable their propellers by using nets. The nets can be carried by another drone or launched from different devices. This particular method was first used in April 2015, in Japan to catch a rogue drone that landed on the roof of the Prime Minister's office while carrying small traces of radioactive material in protest against the government's nuclear energy policies. In a unique approach, Dutch company "Guard from Above" trains eagles to intercept rogue drones. The large birds of prey wear protective shin-guards to protect their legs from the drone's rotors. According to the company's statement, the natural predators trained by certified bird handlers have a 95% intercept rate. The stated success rate is currently higher than many ballistic kinetic solutions.

Examples from Turkey

With the coordination of the Presidency of Defense Industries (SSB), Turkish Defence Industry companies have developed anti-drone technologies to counter the proliferated drone threat against civilian and military areas. Developed by well-renowned defence companies Aselsan, Meteksan Defence, and SDT respectively, the anti-drone systems are designed to protect critical facilities by neutralizing potential Unmanned Aerial Vehicles (UAVs) threats with their integrated RF Jammer capabilities and optional hard-kill features.

Aselsan IHTAR Anti-Drone System

Developed in co-operation with the Turkish Armed Forces and the Presidency of the Defense Industries (SSB), Aselsan IHTAR Anti-Drone System designed to counter mini and micro UAV threats in urban and rural environments. The system is used to protect critical military and commercial sites from Micro/Mini UAV threats. The IHTAR system consists of a Radar and Electro-Optical sensor, RF Countermeasure, Tactical Signal Emulator and Command Control system. In order to utilize the most effective countermeasure in terms of efficiency and security, Aselsan's IHTAR system provides an integrated and coordinated operation of Radar, Electro-Optical sensor, and RF Jammer with command and control capabilities. The system can be operated in mobile of fixed configuration.

Technical Specifications	
Operating Frequency	Ku-Band (12.5-18 GHz)
Instrumental Range	0.3 – 60 km
UAV Detection Range	5 km (RCS: 0,5 m2)
Antenna Rotation Speed	15 rpm
Azimuth Coverage	360°
Elevation Coverage	10°
Elevation Adjustment	±24°
Track-While-Scan (TWS) capability	
Automatic Target Tracking and Multi-target Tracking capability	
Adjustable Sector Width	
Low Probability of Intercept (LPI)	
Operating Temperature	-32°C / +50°C
Storage Temperature	-40°C / +70°C

IHTAR uses the Advanced Capability Aselsan Radar (ACAR) as its primary surveillance sensor. It is a solid-state pulse-doppler radar which operates in Ku-Band (12.5-18 GHz) frequency. ACAR uses a mechanically scanned antenna with selectable rotation speed. The highly accurate radar can scan 360° or a specific sector with adjustable sector width. It can track multiple targets automatically and has a track-while-scan capability in surveillance mode. The radar can also detect mini-UAVs with a radar cross-section of 0.5 m^2 at 5 km. ACAR is used together with an E/O imaging system with both thermal and daylight cameras. This is used for the identification of targets once they have been detected by the radar.

As the primary countermeasure, IHTAR uses the GERGEDAN Active RF Jammer System to provide protection against all known micro and mini UAV attacks. The GERGEDAN system covers all frequency bands and provides simultaneous jamming capability against Remote Control (RC) Devices, Radios (PMR and FRS), GPS receivers, WLAN Applications, ISM Bands, GSM 900, DCS 1800, 3G and 4G. The system also provides directional jamming against specific threats and omnidirectional jamming against swarm attacks with its specially designed antenna creating a semi-spherical protection umbrella.

The IHTAR Anti-Drone System can be combined with jammers, laser, and a 40mm grenade launcher according to the requirements of the customers to provide both soft-kill and hard-kill capabilities. While the RF Jammer is the preferred system to be used in urban areas, the 40mm grenade launcher can be used in critical sites with open fields if needed. As part of the development, the integration of the 40mm grenade launcher into the system is still underway and is expected to be completed within the next year. The IHTAR Anti-Drone System can be operated both manually and automatically and requires only a single crew member. The system incorporates automation and elements of machine learning designed to ensure that the system can counter future threats. IHTAR is customizable with its open and modular architecture which enables integration of different radar and countermeasures into the system.

In addition, IHTAR can also be integrated with Aselsan's CHAMELEON Tactical Signal Emulator to take control of drones by emulating the signals of the RF controller. CHAMELEON can be used as an arbitrary waveform generator or programmable noise generator. It can generate both Electronic Warfare (EW) waveforms and civilian communication waveforms with a single waveform generator.

Meteksan KAPAN Anti-Drone System

The appearance of drones as a threat has become a new topic over the past few years, and there are discussions worldwide about what may be the most effective solution to this threat. There are several aspects to this issue, all of which need to be addressed separately. Meteksan Defence has developed the KAPAN Anti-Drone System as a scalable solution that can handle various missions. KAPAN Anti-Drone System offers superior drone detection and tracking performance with the Retinar FAR Anti-Drone Radar, EO camera system and countermeasure systems provided by Meteksan Defence's solution partners, such as jamming and laser weapon systems.

Unveiled at IDEF 2019, the Retinar FAR is a Meteksan Defence product that provides in-depth analyses and rigorous field tests regarding drone detection. This version of the Retinar fields a new antenna that has been designed specifically for the surveillance of air space and for the detection of drones with high-performance hardware and special algorithms. The Retinar FAR is a pulse-doppler, multi-mode radar using different waveforms, which operates in multi-mode Ka/Ku-Band (26.5-40 GHz/12.5-18 GHz) frequency. The KAPAN Anti-Drone System offers superior drone detection and tracking performance with a radar system and thermal/day cameras and eliminates drones with an RF jammer and an optional laser system. Different systems have been appropriately integrated into the KAPAN Anti-Drone System with standard interfaces and scalable architectures to create an effective solution against drone threats in different situations and scenarios. The Retinar FAR can detect aerial targets at longer ranges (9 km) and scan a broader area (40°), thus turning KAPAN into a more potent drone hunter.

Technical Specifications	
Operating Frequency	Multi-mode Ka/Ku-Band (26.5-40 GHz/12.5-18 GHz)
Instrumental Range	0.1-18 km
UAV Detection Range	2,3 km (RCS: 0,01m2)
Antenna Rotation Speed	16 rpm
Azimuth Coverage	360°
Elevation Coverage	40°
Elevation Adjustment	±35°
Track-While-Scan (TWS) capability	
Automatic Target Tracking and Multi-target Tracking capability	
Adjustable Sector Width	
Low Probability of Intercept (LPI)	
Operating Temperature	-30°C / +50°C
Storage Temperature	-40°C / +60°C

The KAPAN Anti-Drone System is capable of classifying and identifying targets in far distances with low visibility conditions where detection with camera systems is difficult. The highly flexible system can be used on a stationary position or on a vehicle thanks to its single-axis integration and single point connectivity features. The KAPAN Anti-Drone System provides continuous 360° coverage as well as angular surveillance in selected sectors with alarm zone management. Designed to be functional against swarm UAVs, the system can be integrated into existing security systems and reduce unwanted electromagnetic interference with directional jamming.

Furthermore, a Laser Countermeasure System can also be integrated into the KAPAN Anti-Drone System as an optional feature to provide hard-kill capability when requested. The system is capable of destroying and neutralizing drones at 500m with a high-power laser emitter located on the optical tracking and guidance unit. The E/O unit is mounted on a stabilized 3-axis gimbal for precise orientation, and it consists of a SWIR camera, MWIR camera, daylight camera, laser rangefinder, laser optics, GPS, magnetic compass, and image processing sub-units.

President of Meteksan Defence, Selçuk ALPARSLAN emphasized that the KAPAN system has the ability to rapidly respond to newly-emerging threats: "The appearance of drones as a threat is a new topic over the past few years, and there are discussions worldwide about what may be the most effective solution to this threat. There are many aspects to this issue, all of which need to be addressed separately. We have developed the KAPAN Anti-Drone System as a scalable solution that can handle various missions. The KAPAN Anti Drone System consists of the Retinar FAR Anti Drone Radar, camera system and countermeasure systems provided by Meteksan Defence's solution partners, such as jamming and laser weapon systems. The Retinar FAR is a Meteksan Defence product that provides in-depth analyses and rigorous field tests regarding drone detection. This version of the Retinar fields a new antenna that has been designed specifically for the surveillance of air space and for the detection of drones with high-performance hardware and special algorithms."

In the last quarter of 2017, Meteksan Defence secured the first export contract for the Retinar PTR with an undisclosed country. The company scored its second export success on July 12, 2018, with the Retinar PTR-X, an improved version of the PTR Radar. The system was selected as the perimeter surveillance system of an unnamed airport in the capital of a European country, and it has been in use ever since.

SDT AVCI Anti-Drone System

The SDT AVCI Anti-Drone System is designed to detect, track and defeat Micro and Mini Unmanned Aerial Vehicles (UAVs) and Unmanned Aircraft Systems (UAS) engaged in hostile airborne surveillance and potentially hostile activity. SDT developed the AVCI system to meet the specific requirements of the Turkish Armed Forces and security forces. AVCI is a smart-sensor and countermeasure package capable of remotely detecting small UAVs and then tracking and classifying them before providing the option to disrupt their activity. The thermal cameras on the system are provided by the Turkish company Mikro-Tasarım. The system combines electronic-scanning radar target detection, electro-optical (EO) tracking/ classification and directional RF jamming capability. Unlike other similar Turkish systems that use mechanically scanned radars, the AVCI system employs PESA (Passive Electronically Scanned Array) radars produced by UK based Blighter Surveillance Systems. During IDEF 2019, SDT signed an agreement with Blighter to locally produce the radars.

The AVCI Anti-Drone System uses A400 Series Radars which operate in Ku-band frequency. The radar is a modular non-rotating, electronic-scanning (e-scan) system using power efficient PESA (passive electronically scanned array) and FMCW (frequency modulated continuous wave) technologies to provide reliable, Micro and Mini UAV detection in all-weather conditions. It is able to detect UAVs with a radar cross-section of 0.01m2 at ranges up to 10 km. The A400 series radars use D3 (Digital Drone Detection) technology that enables them to extract tiny radar reflections from modern plastic bodied UAVs even when flying close to the ground or near buildings where clutter reflections are relatively large. The

Technical Specifications	
Operating Frequency	Ku-Band (12.5-18 GHz)
Instrumental Range	0.1-10 km
UAV Detection Range	2,4 km (RCS: 0,01m2)
Azimuth Coverage	180° (Standard) or 360° (Dual)
Elevation Coverage	20° (Standard) or 30° (Extended)
Elevation Adjustment	-40° to +30°
Advanced PESA e-scan and FMCW technology	
Automatic Target Tracking and Multi-target Tracking capability	
Adjustable Sector Width	
Fast Scan Time (90° in 1s)	
Operating Temperature	-32°C / +60°C

radar covers 180° and can be used in back-to-back configuration to provide 360° surveillance. Target tracking software and extensive zone filtering features allow drones to be detected while reducing false alarms from birds.

The AVCI system weighs around 350kg and SDT is currently working on a lighter version of the system to be used on military surveillance vehicles. The system may be used in remote or urban areas to prevent UAVs from being used for attacks or malicious activities against sites with critical infrastructure. The SDT AVCI Anti-Drone System can use various sensor subsystem configurations based on requirements. Detected drones can be defeated using directional/ omnidirectional jamming solutions or hard-kill solutions.

Although these indigenous counter UAV systems were designed and developed to primarily protect military bases and critical facilities, the growing interest in commercial unmanned systems and the changing threat environment by extension, created a need for the use of these systems in civilian environments. Ever since the drone-related incidents, and the questions that arose regarding the security of crowded places, counter-drone systems began to appear at various events and risky locations such as airports, stadiums, and convention centers with increasing regularity. Regarding the recent incidents, the growing demand for anti-drone systems from outside the military domain is expected to play an important role in accelerating the efforts to develop more integrated and cost-effective solutions in the coming years.

Conclusion

The need for anti-drone systems has once again been revealed with the increasing number of illegal activities carried out with drones, which are now easily accessible in the civilian market. There has been a significant increase in drone-related incidents and illegal activities reported over recent years. It is clear that drones can be used for malicious intent, and this will pose a far greater threat in the future with the advancement of technology. Thus, it is highly essential to introduce the necessary regulations and establish a nationwide multi-layer defence network against UAV threats for the protection of critical facilities. Preventing the use of UAVs by terrorist and criminal organizations for the national security of our country is also another issue that should be taken into consideration. Considering the new developments in UAV technology and the possibility that today's anti-drone systems would not provide sufficient protection in the future, studies on anti-drone systems should proceed without slowing down


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