Supplementary documentation to European Union Non-Proliferation and Disarmament Paper no. 65: European research on military swarms

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Table 1 shows a non-exhaustive list of European Union (EU)-coordinated or EU-funded research and development (R&D) projects on swarms that are military-oriented or dual-use with an explicitly mentioned security purpose, listed in chronological order. Table 2 shows a list of similar R&D projects funded by EU member states or European defence companies, also in chronological order.

Two caveats apply, such that the lists in both tables should be considered neither representative nor exhaustive. First, it is not always clear whether a project involves swarms or any multi-robot team, either because only limited information is available or there is disagreement in the technical literature on what exactly constitutes a swarm. Second, it is possible and even likely that not all relevant projects have been included due to the secrecy surrounding all military research, the sensitivity of both swarming and EU defence research, and the wide range of programmes involved.

Table 1: EU-funded R&D projects on swarms with a military or security angle

EU funding programmes: EDA: European Defence Agency; EDPIP: European Defence Industrial Development Programme; FP7: 7th Framework Programme for Research and Technological Development; H2020: Horizon 2020; PADR: Preparatory Action on Defence Research; PESCO: Permanent Structured Cooperation; PP: Pilot Project;

Project name	Duration	Programme	Participants (country)	Description
Networked Multi-Robot Systems[a]	2007–10	EDA	Diehl BGT Defence (DE), Fraunhofer (DE), OTO Melara (IT), Celin Avio (IT), Scuola Superiore Sant'Anne (IT), Sener (ES), Politechnical University of Madrid (ES), Royal Military Academy (BE)	Simulation of a networked multi-robot system performing autonomously coordinated operations.[r].
Scenarios for Multiple Unmanned Vehicles Operations (SMUVO)[b]	2009–10	EDA	BMT Defence Services (UK), Newman & Spurr Consultancy (UK)	Assessment of the value of heterogeneous teams of robots.[r]

Project name	Duration	Programme	Participants (country)	Description
Marine Robotic System of Self-Organizing, Logically Linked Physical Nodes (MORPH)[c]	2012–16	FP7	National Institute for Ocean Science (FR), University of Ilmenau (DE), Atlas Elektronic (DE), Jacobs University (DE), University of Girona (ES), Consiglio Nazionale delle Ricerche (IT), Institute of Robotics of the Instituto Superior Técnico (PT), University of Azores (PT), NATO Centre for Maritime Research and Experimentation	Development of physically morphing, closely coupled robot modules that are linked together in a network and that self-organize how to execute missions.
Network Enabled Cooperation System of Autonomous Vehicles (NECSAVE)[d]	2013–17	EDA	University of Porto (PT), Port of Leixoes (PT), OceanScan (PT), Calzoni (IT), Universidad Complutense de Madrid (ES), Royal Military Academy (BE), Netherlands Organisation for Applied Scientific Research (NL)	Development of a heterogeneous network of nods in an underwater swarm.
Technologies for multi-robots control in support of the soldier (MuRoC)[e]	2014–15	EDA	Diehl BGT Defence (DE), ECA Robotics (FR), Sener (ES)	Survey of the market in multi-robot research.
Aid to SItuation management based on MUltimodal, MUltiUAVs, MUltilevel acquisition Techniques (ASIMUT)[f]	2015–17	EDA	Thales (FR), Fraunhofer (DE), Fly-n-Sense (FR), University of Bordeaux (FR), University of Luxembourg (LU)	Research into decreasing the workload of operators during surveillance mission executed by swarms of unmanned aerial systems (UAS).
ICEYE[g]	2015–17	H2020	ICEYE (FI)	Development of a swarm of small satellites to gather synthetic aperture radar data for Earth observation.

Project name	Duration	Programme	Participants (country)	Description
Smart and Networking UnderWAter Robots in Cooperation Meshes (SWARMs)[h]	2015–18	H2020	Maritime Robo (NO), Water Linked (NO), Inventas (NO), Sintef (NO), Norwegian University of Science and Technology (NO), Mälardalen University Sweden (SE), Deepvision (SE), Evologics (DE), Bosch (DE), S[&]T (NL), Netherlands Organisation for Applied Scientific Research (NL), Onera (FR), Thales (FR), ECA Robotics (FR), GS LDA (PT), Institute of Telecommunication (PT), University of Aveiro (PT), TTI Norte (ES), Tenalia (ES), Politechnical University of Madrid (ES), Acciona (ES), HI-Iberia (ES), Plocan (ES), WASS (IT), Sant'Anna School of Advanced Studies (IT), Desistek (TR), Sabanci University (TR), Teamnet (BG), Autonomous Systems (BG)	Development of a 'cooperative mesh' (or swarm) of unmanned underwater systems to collaborate and open up new missions, and increase their autonomy. The project is mostly civilian-oriented, but several defence companies participated and produced papers on intrusions in military networks, underwater communication for military systems, and detection avoidance from adversaries.
Swarm of Biomimetic Underwater Vehicles for Underwater ISR (SABUVIS)[i]	2015–	EDA	Polish Naval Academy (PL), Bundeswehr Technical Centre for Ship and Naval Weapons Maritime Technology and Research (DE), PIAP (PL), Naval Research Centre of the Portugal Naval School (PT), Kraków University of Technology (PL), FORKOS (PL)	Development of a biomimetic (resembling nature) underwater swarm for intelligence, surveillance and reconnaissance (ISR).
EuroSWARM[j]	2016–17	PP	University of Cranfield (UK), ONERA (FR), Swedish Defence Research Agency (SE), University of Patras (EL)	Development of command and control (C2) architecture for autonomous and heterogeneous swarms of sensors.
EDA Innovation Prize[k]	2018	EDA	Clover Technologies (ES)	Development of a blockchain-based common platform for swarm nodes.

Project name	Duration	Programme	Participants (country)	Description
ROBORDER[l]	2017–21	H2020	Centre for Research and Technology Hellas (EL), Fraunhofer (DE), Estonian Academy of Security Sciences (EE), VTT Technical Research Centre of Finland (FI), EVERIS (BE), Police Service of Northern Ireland (UK), Portugese National Guard (PT), NATO STO CMRE, Hungarian National Police (HU), Robotnik Automation SLL (ES), Romanian Protection and Guard Service (RO), Elettronica (DE), Greek Ministry of Defence (EL), CENTRIC at Sheffield Hallam University (UK), North Tyrrhenian Sea Port System Authority (IT), OceanScan (PT), COPTING (DE), National and Kapodistrian University of Athens (EL), Swiss Center for Electronics and Microtechnology (CH), National Interuniversity Consortium for Telecommunications (IT), Portugese Criminal Police (PT), Capritech (UK), Romanian Border Police (RO), TEKEVER (UK)	Development of an autonomous swarm of heterogeneous robots for border surveillance in a wide range of operational and environmental settings. Missions include border surveillance, marine pollution detection, and early autonomous identification of criminal activities and hazardous incidents.
CPSwarm[m]	2017–20	H2020	LINKS (IT), University of Klagenfurt (AU), Fraunhofer (DE), TTTech (AU), Lakeside Labs (AU), Search-Lab (HU), DigiSky (IT), Robotnik (ES), Softeam Cadextan (FR)	Integration of cyber-physical systems into a swarm to use for surveillance.

Project name	Duration	Programme	Participants (country)	Description
Ocean2020[n]	2018–21	PADR	Leonardo (IT), Indra (ES), Saab (SE), PGZ/CTM (PL), Safran (FR), INTRACOM DEFENCE (EL), Qinetiq (UK), Skysoft (PT), MBDA (EUR), IDS (IT), GMV Aerospace and Defence (FR), Terma (DK), ECA Robotics (FR), Fincantieri (IT), E-Geos And Hensoldt (DE), Baltic Institute of Advanced Technology (PL), Cybernetica (EE), Barracuda (EL), Seadrone (FR), Autonaut (UK), Blue Bear (UK), Prolexia (FR), Schönhofer (DE), Antycip (FR), Infinite Vision (DE), Insis (IT), Altus (EL), Luciad (BE), Blackshape (IT), Centre for Maritime Research and Experimentation (BE), Frauhofer (DE), Netherlands Organisation for Applied Scientific Research (NL), VTT Technical Research Centre of Finland (FI), National Interuniversity Consortium for Telecommunications (IT), University of Athens (EL), IAI (IT), Italian Navy (IT), Lithuanian Navy (LT), Greek Defense Ministry (EL), Portuguese Navy (PT), Spanish Defense Ministry (ES), and the Ministries of Defence of Sweden, France, the United Kingdom, Estonia and the Netherlands	Development of a heterogeneous network of aerial, underwater and surface unmanned systems (UxS), and development of a network with the C2 centres of manned naval units. One of the major sub-goals is to develop increased autonomy for UxS and swarm operations to enable monitoring of maritime environments.
Integrated Unmanned Ground System (UGS)[o]	2018–?	PESCO	BE, CZ, EE, ES, FI, FR, HU, LA, NL, PO	Development of a modular unmanned ground system capable of carrying different payloads and for use in a variety of missions. A sub-goal is the development of an electronic warfare-resilient C2 interface capable of swarming.
ISR-TRPAs[p]	2019–	EDIDP	*Call currently open*	Development of tactical aerial UxS to use for ISR. A sub-goal is to develop swarming capabilities to improve ISR operations.

Project name	Duration	Programme	Participants (country)	Description
Airborne electronic attack capability[q]	2019–	EDIDP	*Call currently open*	Development of airborne attack capabilities. A sub-goal is to develop a system to control electronic attack operations of UAV swarms.[s]

[a] Diehl and BGT Defence, 'Networked multi-robot systems: executive summary', 28 Oct. 2010, <https://www.eda.europa.eu/docs/default-source/projects/nm-rs_es.pdf>.

[b] Detratti, M., 'Robotics in defence', *European Defence Matters*, no. 14 (2017) <https://www.eda.europa.eu/webzine/issue14/cover-story/robotics-in-defence>.

[c] Kalwa, J. et al., 'EU Project MORPH: current status after 3 years of cooperation under and above water', *IFAC-PapersOnLine*, vol. 48, no. 2 (2015), pp. 119–24.

[d] Pinto, J. et al., 'Network enabled cooperation of autonomous vehicles: a communications perspective', OCEANS 2017, 19–22 June 2017, Aberdeen, <https://doi.org/10.1109/OCEANSE.2017.8084774>, pp. 1–6.

[e] Diehl Defence, ECA Robotics and Sener, 'Multi-robot control in support of the soldier', European Defence Agency (EDA), 7 Mar. 2015, <https://www.eda.europa.eu/docs/default-source/documents/muroc_es.pdf>.

[f] Bouvry, P. et al., 'ASIMUT project: Aid to SItuation Management based on MUltimodal, MUltiUAVs, MUltilevel acquisition Techniques', 3rd Workshop on Micro Aerial Vehicle Networks, Systems, and Applications, 23 June 2017, Niagara Falls, <https://doi.org/10.1145/3086439.3086445>, pp. 17–20; Bouvry, P. et al., 'Using heterogeneous multilevel swarms of UAVs and high-level data fusion to support situation management in surveillance scenarios', 2016 IEEE International Conference on Multisensor Fusion and Integration for Intelligent Systems (MFI), 19–21 Sep. 2016, Daegu, <https://doi.org/10.1109/MFI.2016.7849525>, pp. 424–29; Rosalie, M. et al., 'From random process to chaotic behavior in swarms of UAVs', 6th ACM Symposium on Development and Analysis of Intelligent Vehicular Networks and Applications – DIVANet '16, 13–17 Nov. 2016, Malta, <https://doi.org/10.1145/2989275.2989281>, pp. 9–15; Rosalie, M. et al., 'UAV multilevel swarms for situation management', 2nd Workshop on Micro Aerial Vehicle Networks, Systems, and Applications for Civilian Use – DroNet '16, 26 June 2016, Singapore, <https://doi.org/10.1145/2935620.2935631>, pp. 49–52.

[g] CORDIS, 'Satellite imaging technology for safer Arctic operations', European Commission, 20 Aug. 2018, <https://cordis.europa.eu/project/rcn/198532/brief/en>; Willmer, G., 'Microsatellite swarms could paint clearer picture of our planet', *Horizon: the EU Research & Innovation magazine*, 28 May 2018, <https://horizon-magazine.eu/article/microsatellite-swarms-could-paint-clearer-picture-our-planet.html>.

[h] SWARMs, *SWARMs Newsletter*, no. 3 (Oct. 2017), < http://www.swarms.eu/dissemination.html#newsletters>; TNO, 'Underwater communication: how it is done', *TNO Insights*, 1 Oct. 2015, <https://www.tno.nl/en/tno-insights/articles/underwater-communication-how-it-is-done/>; Al-Rawi, M. et al., 'Data redundancy may lead to unreliable intrusion detection systems', 13th International Wireless Communications and Mobile Computing Conference, 26–30 June 2017, Valencia, <https://doi.org/10.1109/IWCMC.2017.7986573>, pp. 1897–1902; Mirebeau, J. and Dreo, J., 'Automatic differentiation of non-holonomic fast marching for computing most threatening trajectories under sensors surveillance', eds F. Nielsen and F. Barbaresco, *Geometric Science of Information* (Springer: Cham, 2017), pp. 791–800; Dol, H. et al., 'Characterizing the underwater acoustic communications channel in shallow estuaries and its application to the development of a flexible wideband modulation', International Conference and Exhibition on Underwater Acoustics, 30 June – 5 July 2019, Crete, <http://www.uaconferences.org/index.php/component/contentbuilder/details/9/119/uace2019-characterizing-the-underwater-acoustic-communications-channel-in-shallow-estuaries-and-its-application-to-the-development-of-a-flexible-wideband-modulation?Itemid=410&start=0>, pp. 933–40.

[i] Przemysłowy Instytut Automatyki i Pomiarów (PIAP), 'The "SABUVIS" project', n.d., <https://piap.pl/en/research-projects/the-sabuvis-project/>; EDA, 'EDA expands work on autonomous underwater vehicles', Press Release, 27 Sep. 2019, <https://www.eda.europa.eu/info-hub/press-centre/latest-news/2019/09/27/eda-expands-work-on-autonomous-underwater-vehicles>. Szymak, P. and Piskur, P., 'Using particle swarm optimization for tuning course controller of biomimetic underwater vehicle', May 2019, <https://www.researchgate.net/publication/332858808_Using_Particle_Swarm_Optimization_for_Tuning_Course_Controller_of_Biomimetic_Underwater_Vehicle>.

[j] EDA Pilot Project and Preparatory Action on Defence Research, 'Unmanned heterogeneous swarm of sensor platforms (EuroSWARM)', Grant Agreement PP-15-INR-01, <https://www.eda.europa.eu/what-we-do/activities/activities-search/pilot-project-and-preparatory-action-for-defence-research>; Marzat, J., Piet-Lahanier, H. and Bertrand, S., 'Cooperative fault detection and isolation in a surveillance sensor network: a case study', 10th IFAC Symposium on Fault Detection, Supervision and Safety for Technical Processes (SAFEPROCESS 2018), vol. 51, no. 24 (1 Jan. 2018), <https://doi.org/10.1016/j.ifacol.2018.09.665>, pp. 790–97; Lappas, V. et al., 'Autonomous unmanned heterogeneous vehicles for persistent monitoring', AIAA Scitech 2019 Forum, 7–11 Jan. 2019, San Diego, <https://arc.aiaa.org/doi/abs/10.2514/6.2019-1164>, pp. 1–24; Shin, H. et al., 'Behavior monitoring using learning techniques and regular-expressions-based pattern matching', *IEEE Transactions on Intelligent Transportation Systems*, vol. 20, no. 4 (Apr. 2019) <https://doi.org/10.1109/TITS.2018.2849266>, pp. 1289–1302.

[k] EDA, 'Research & technology SMEs win 1st EDA Defence Innovation Prize', Press Release, 19 Oct. 2018, <https://eda.europa.eu/info-hub/press-centre/latest-news/2018/10/19/research-technology-smes-win-1st-eda-defence-innovation-prize>.

[l] European Commission, CORDIS, 'Autonomous swarm of heterogeneous RObots for BORDER surveillance', Fact Sheet, 14 June 2019, <https://cordis.europa.eu/project/rcn/209949/factsheet/en>; Monroy, M., 'Land, sea and air: EU Member States test drones for border surveillance', *Security Architectures and Police Collaboration in the EU*, 21 Aug. 2019, <https://digit.site36.net/2019/08/21/land-sea-and-air-eu-member-states-test-drones-for-border-surveillance/>; Rodrigues, F. et al., 'ROBORDER: mid-term review and progress report', ROBORDER Report, 30 Nov. 2018, <https://roborder.eu/wp-content/uploads/2019/01/D8.3_740593_Mid-term-review-and-progress-report.pdf>.

[m] Bagnato, A. et al., 'Designing swarms of cyber-physical systems: the H2020 CPSwarm project', ACM International Conference on Computing Frontiers 2017, 15–17 May 2017, Siena, <https://mobile.aau.at/publications/bagnato-2017-Designing-Swarms-of-Cyber-Physical-Systems.pdf>.

[n] EDA, Ocean2020, 'Ocean2020 project: project overview', Nov. 2018, <https://ocean2020.eu/wp-content/uploads/2018/11/ocean2020-project-presentation.pdf>; Gain, N., 'OCEAN2020 project technologies tested in the Baltic Sea', *Naval News*, 21 Aug. 2019, <https://www.navalnews.com/naval-news/2019/08/ocean2020-project-technologies-tested-in-the-baltic-sea/>.

[o] EDA, 'Call – Multipurpose Unmanned Ground System (Call for Proposals – 2019)', Draft call for proposals, EDIDP-MUGS-2019, Aug. 2019 <https://systematic-paris-region.org/wp-content/uploads/2019/04/limited_edidp_call_text_412_2019_finalAAA.pdf>.

[p] European Commission, 'European Defence Industrial Development Programme (EDIDP): 2019 calls for proposals, conditions for the calls and annex', Call for proposals v. 1.1, 22 July 2019, <http://ec.europa.eu/research/participants/data/ref/other_eu_prog/edidp/wp-call/edidp_call-texts-2019_en.pdf>.

[q] European Commission, 'European Defence Industrial Development Programme (EDIDP): 2019 Calls for Proposals, Conditions for the Calls and Annex' European Union, 4 Apr. 2019, <http://ec.europa.eu/research/participants/data/ref/other_eu_prog/edidp/wp-call/edidp_call-texts-2019_en.pdf>; Sprenger, S. 'Europeans propose siccing self-learning drone swarms on air defenses', *Defense News*, 22 Oct., 2019, <https://www.defensenews.com/global/europe/2019/10/22/europeans-propose-siccing-self-learning-drone-swarms-on-air-defenses/>.

[r] There is insufficient information to determine whether the technology is a 'swarm' or a multi-robot system, but the project is included because the science can aid in the development of swarms.

[s] The project mentioned in section VI of the main paper is a proposal under this programme.

Table 2: R&D projects on swarms with a military or security angle funded by European countries or defence companies

Project name	Duration	Countries/companies	Description
SUSIE[a]	2009–12	FR	Research into supervisory control of swarm intelligence.
Cooperative Autonomous Reconfigurable UAV Swarm (CARUS)[b]	2010–12	FR	Development of a reconfigurable swarm of unmanned aerial systems (UAS).
Many Drones Make Light Work[c]	2016–21	UK	Evaluation of the benefits of UAS swarms.
Tempest[d]	2018–35	UK, SE	Development of an optionally manned fighter jet that will control drone swarms in a human–machine teaming configuration.
Lightweight Affordable Novel Combat Aircraft (LANCA)[e]	2019–22	UK	Development of UAS squadrons that can jam enemy air defences.
Future Combat Air Systems (FCAS)[f]	2019–40	FR, DE, ES	Development of an optionally manned fighter jet that will control drone swarms in a human–machine teaming configuration.
WARMATE[g]	?–2019	Rheinmetall (DE), WB GROUP (PL)	Development of a loitering munition that can carry out surgical swarm attacks, integrated into the Rheinmetall Mission Master (an unmanned ground vehicle).
GIMNOTE programme[h]	2019–	FR	Research into aerial and surface naval micro drones in a swarm.
Manned–Unmanned Teaming (MUT)[i]	?–2025	Airbus (EUR)	Development of a drone escort system for combat aircraft.
Situational Awareness Virtual EnviRonment (SAVIER)[j]	?	Airbus (EUR)	Development of a demonstrator for a ground station for UAS, including but not limited to swarms.
Swarm architecture for air defence[k]	?	SENER (ES)	Development of an architecture for a heterogeneous group of systems to be used for ground-based air defence.
Smart Glider[l]	?	MBDA (EUR)	Development of gliding weapons that can carry out swarm attacks.
Piraya USS[m]	?	Saab (SE)	Development of a swarm of unmanned surface systems.
Real-Time Swarm Intelligence Platform (RT-SIP)[n]	?	Sistemi Software Integrati (IT)	Development of software architecture for swarms.

Project name	Duration	Countries/companies	Description
Leopardo UGS[o]	?	Eurolink (IT)	Investigation into feasibility of a robot swarm capable of autonomously developing a strategy to accomplish a mission, sharing information and reacting to potential challenges such as one or more unit failures.

[a] French Ministry of Defence, 'Susie : Piloter Un Essaim de Drones', [Susie: to pilot a swarm of drones], , 25 June 2011, <https://www.defense.gouv.fr/english/actualites/economie-et-technologie/susie-piloter-un-essaim-de-drones>.

[b] Chaumette, S. et al., 'CARUS, an operational retasking application for a swarm of autonomous UAVs: first return on experience', 2011 Military Communications Conference, 7–10 Nov. 2011, Baltimore, <https://doi.org/10.1109/MILCOM.2011.6127613>, pp. 2003–10.

[c] United Kingdom Government, Ministry of Defence, '£2.5m injection for drone swarms', Press Release, 28 Mar. 2019, <https://www.gov.uk/government/news/25m-injection-for-drone-swarms>; UK Government, Defence Science and Technology Laboratory, 'Defence and Security Accelerator funded contracts: 1 April 2016 to 31 March 2017', 25 June 2019, <https://www.gov.uk/government/publications/accelerator-funded-contracts/accelerator-funded-contracts-1-april-2016-to-31-march-2017>.

[d] Davies, R., 'UK unveils new Tempest fighter jet to replace Typhoon', *The Guardian*, 16 July 2018, <https://www.theguardian.com/uk-news/2018/jul/16/uk-tempest-fighter-jet-typhoon-farnborough-airshow>.

[e] Trevithick, J. and Rogoway, T., 'Let's talk about the U.K.'s sudden move to field a drone swarm squadron', *The Drive*, 12 Feb. 2019, <https://www.thedrive.com/the-war-zone/26467/u-k-s-sudden-move-to-field-a-drone-swarm-squadron-may-point-to-bigger-unmanned-developments>.

[f] Brzozowski, A., 'Next-generation european fighter jet cooperation ready for take-off', *Euractiv*, 17 June 2019, <https://www.euractiv.com/section/defence-and-security/news/next-generation-european-fighter-jet-cooperation-ready-for-take-off/>.

[g] 'Rheinmetall presents the world's first unmanned ground vehicle equipped with micro combat unmanned air vehicle at MSPO 2019', *DefesaNet*, 9 Apr. 2019, <http://www.defesanet.com.br/en/land/noticia/34117/Rheinmetall-presents-the-world%E2%80%99s-first-unmanned-ground-vehicle-equipped-with-micro-combat-unmanned-air-vehicle-at-MSPO-2019/>; 'MSPO 2019: Rheinmetall presents Mission Master UGV with Warmate loitering munition', Jane's by IHS Markit YouTube channel, 6 Sep. 2019, <https://www.youtube.com/watch?v=H_O85m6VXn8>.

[h] French Ministry of Defence, Directorate General of Armament, 'Le cluster d'innovation navale de défense sélectionne ses premiers projets' [Naval defence innovation cluster selects its first projects], 31 Jan. 2019, <https://www.defense.gouv.fr/dga/actualite/le-cluster-d-innovation-navale-de-defense-selectionne-ses-premiers-projets>; Lagneau, L., 'Bientôt des essaims de micro-drones pour la Marine nationale?' [Swarms of micro-drones for the French Navy soon?], *Zone Militaire*, 10 Feb. 2019, <http://www.opex360.com/2019/02/10/bientot-des-essaims-de-micro-drones-pour-la-marine-nationale/>.

[i] Airbus, 'Airbus demonstrates manned–unmanned teaming for future air combat systems', Press Release, 2 Oct. 2018, <https://www.airbus.com/newsroom/stories/Airbus-demonstrates-MUT.html>; 'Airbus Testet Drohnenschwarm an Der Ostseeküste' [Airbus tests drone swarm on the Baltic Sea coast], *Spiegel*, 10 Apr. 2018, <https://www.spiegel.de/wissenschaft/technik/airbus-testet-drohnenschwarm-an-der-ostseekueste-a-1231509.html>.

[j] Fernandez, V. R. et al., 'SAVIER Project – Situational Awareness Virtual EnviRonment – Airbus Defence & Space', Project description, ResearchGate, n.d., <https://www.researchgate.net/project/SAVIER-Project-Situational-Awareness-Virtual-EnviRonment-Airbus-Defence-Space>.

[k] Melgar, I. et al., 'Swarm architectures for ground-based air defense systems of systems', 2009 7th IEEE International Conference on Industrial Informatics, 23–26 June 2009, Cardiff, <https://doi.org/10.1109/INDIN.2009.5195902>, pp. 783–88; Melgar, I. et al., 'Cooperation and Competition based on free market in swarm system architectures for air defense', 2009 35th Annual Conference of IEEE Industrial Electronics, 3–5 Nov. 2009, Porto, <https://doi.org/10.1109/IECON.2009.5415196>, pp. 3359–64.

[l] Donald, D., 'MBDA unveils SCAF weapons vision', *Aviation International News*, 16 June 2019, <https://www.ainonline.com/aviation-news/defense/2019-06-16/mbda-unveils-scaf-weapons-vision>.

[m] Berg, R., 'Submarine and naval ship design for the littorals – Saab Kockums', 24 Jan. 2014, <https://my.nps.edu/documents/105575500/106894543/Sub+and+ship+design+Roger+Berg.pdf/c108effc-8471-4e43-9d51-86f06114c5ae>; Rogers, D., 'Re: the potential use by the Australian Defence Force of unmanned air, maritime and land platforms', Australian Government Senate Inquiry into the potential use by the Australian Defence Force of unmanned air, maritime and land platforms, Submission no. 24 (Letter), 20 Feb. 2015, <https://www.aph.gov.au/DocumentStore.ashx?id=09661303-1f3b-49c1-95f1-7a0efd282d10&subId=303542>.

[n] Fedi, F., 'Swarm-centric multirobot systems: the Sistemi Software Integrati solution', 2012 IEEE First AESS European Conference on Satellite Telecommunications, 2–5 Oct. 2012, <https://doi.org/10.1109/ESTEL.2012.6400179>.

[o] Lapiana, P., 'The Fourth Industrial Revolution: robotics and drones, reality and future', *Italy Aerospace 2016*, Global Business Report, 30 Nov. 2016, < https://www.gbreports.com/publication/italy-aerospace-2016_1>.