LIST OF NIAG IAMD STUDIES

Serial	SG Number	Report Date	Class	Study Title	DI Portal URL:	Scope of Study
1	SG-148	15-Sep-11	NU REL PfP	Analysis of Information Exchange Requirements to Enable Ground Based Air Defence (GBAD) Systems Open Architecture Development	SG-148 Final Report	The Study concluded that an improvement in Sensor Data Fusion (SDF) information exchange (collaborative SDF) would provide a significant capability enhancement and a key enabler for any future collaborative GBAD Threat Evaluation and Weapon Assignment (TEWA) capability, which offered the potential of more effective management of the scarce future GBAD resources (Sensors, Effectors and Communications Media). It was also foreseen that a future improved interaction between the SDF and TEWA would lead to optimal use of the tactical network resources, in the sense that targets subject to engagement decisions can be prioritizes for full SDF treatment. Any future tactical radio system will employ IP technology and be based on Software Designed Radio (SDR) principles. There were also security architecture and infrastructure challenges that would need to be overcome. Current Tactical Data Links (TDLs) do not fully support the metadata exchange requirements needed for collaborative SDF. Developments based on a Data Distribution Service (DDS) and XML/CIXS is expected to provide the flexibility needed to exchange the characteristics of collaborating SDF implementations and the products, such as covariance matrix data, inherent in these systems and needed to coordinate the air picture production resulting from SDF.

2	SG-160	18-Dec-12	NU REL PfP	NATO Ground Based Air Defence Threat Evaluation and Weapon Assignment (TEWA) Interoperability	SG-160 Final Report	The Study concluded that an improved information exchange between national GBAD elements in a multi-national force package will contribute towards an enriched Single Integrated Air Picture (SIAP), thereby enhancing situational awareness and providing improved data on which to base engagement decisions. It was considered that an improvement in TEWA information exchange (collaborative TEWA) would be a significant force multiplier and a key enabler for any future NATO GBAD multi-national force package, offering the potential for the more effective management/use of scarce GBAD resources (Sensors, Effectors and Communications Media). It was recommended that this operational benefit should be reflected in an update to the existing NATO Staff Requirements (NSR) for GBAD. It was also foreseen that a future improved interaction between SDF and TEWA would lead to the optimal use of the tactical network resources. A more coherent awareness of the GBAD environment also offered operational benefits in that more enriched target threat information could be exchanged with NATO's Theatre Missile Defence (TMD)
3	SG-170	16-Sep-13	NU REL PfP	Engagment of Low, Slow and Small Targets by GBAD	SG-170 Final Report	First of a series of studies into the neutralisation of Low, Slow and Small (LSS) Unmanned Aircraft Systems (UAS). The Study analysed the utility of extant GBAD systems in the Counter LSS (C-LSS) role. The main finding was that no one GBAD sensor or effector could provide an effective defence against representative LSS threat profiles. A number of scenarios and vignettes were developed for the Study for use in supporting the analysis of a number of use cases.

4	SG-188	16-Jul-15	NU REL PfP	GBAD Sensor Mix Option for Emerging Threats	SG-188 Final Report	This Study explored the utilisation of extant and new GBAD sensors required to provide an effective defence against the LSS threats. The concept of sensor clusters was discussed and how the GBAD C2 architecture would need to be adapted to accommodate this change. The potential use of cloud computing was also examined. The SG-170 scenarios and vignettes were revised to meet the needs of the SG-188 analysis.
5	SG-200	06-Nov-17	NU REL AUS/FIN/IRE / SWE/ SWI	Low, Slow and Small Threat Effectors Study	SG-200 Final Report	Having addressed the broader GBAD capability shortfalls in the previous two studies, this Study examined the many C-LSS effector options. Both kinetic and non-kinetis effectors were considered during the analysis. As with the previous study, it was determined that a sensor and effector toolbox concept was necessary, with the appropriate sensor(s) and effector(s) being selected to meet the challeges of the specific mission type(s).
6	SG-217	12-Feb-19	NU REL IP	Standards for Integrated Air and Missile Defence (IAMD) Multifunction Sensors Networking into Fire Control Clusters	SG-217 Phase 2 Final Report	The two phases of the Study conducted an analysis and defined service exchanges between IAMD Multifunction Fire Control radar systems, gathered and networked by high-speed datalinks into multi sensor (Fire Control) clusters. The expected operational benefit was to obtain an enhancement of the overall system performance, reactivity and obtain better resilience to the environment or to the threat effects, due to high dynamic of data and services exchange to adapt the multi sensor (Fire Control) cluster resources in real time. Recommendations on the future standards of interoperability between IAMD fire control systems operating in a network were also presented.

7	SG-220	05-Nov-19	NU REL FIN/ SWE/ SWI	GBAD Operations in the 21st Century Against a Peer State Threat	SG-220 Final Report	This 2-year Study included a detailed analysis of the full threat spectrum that could be expected when faced with a Peer state adversary. The utility of the extant GBAD systems against the full range of threats was considered and a matrix developed to record the results of the analysis and highlight the GBAD capability shortfalls. The threats and systems were generic in nature but were representative of those in the real world. As well as consideration of performance in a benign EM environment, the Study looked for the first time at the impact of EW and Cyberspace operations against GBAD forces. The threats of most concern were at the highly manoeuvrable and fast end of the spectrum and the LSS threats at the other end of the spectrum.
8	SG-238	22-Apr-21	NU	GBAD Operations against the 21st Century Peer Nation Cruise Missile and Unmanned Aerial Systems (UAS)	SG-238 Final Report	This Study focused on the two challenging threat sets identified from the previous study, with the threat catalogue being reviewed and updated. Further analysis of the EM environment in terms of EW and Cyber was undertaken and the impact of 5G and satellite communications was considered. The introduction of AI amd ML technologies into the GBAD domain was examined, going from basic technological principles to the specific application and benefits that the introduction of these technologies could offer. The Study also considered how the introduction of new technologies could impact GBAD C2 and the architectual design.

9	SG-260	03-Jun-22	NU REL IP	Standards for Integrated Air and Missile Defence (IAMD) multifunction sensors networking into fire control clusters	SG-260 Final Report	NIAG Study SG-260 is the third in a series of ACT funded studies that started in 2017. This series of studies assesses the challenges and efficacy of developing standards for Integrated Air and Missile Defense (IAMD) multifunction sensors, enabling them to network across fire control clusters among systems provided by the member nations of the NATO Alliance. The study addresses the utility and highlights the benefits of networking the fire control systems of national air and missile defense assets through data and services sharing (including search and active tracking) to achieve greater efficiency and performance. An Integrated Air and Missile Defense (IAMD) system is built on a system centric architecture including fire control multifunction radars, fire control command centers, missile launchers, and a surveillance radar if the surveillance function is not achieved by the fire control multifunction radar. The study applied the analysis of progressive and flexible networking fire control systems (netcentric architecture) to real world near peer threat scenarios that have already appeared on the European continent: hypervelocity cruise missiles, maneuvering ballistic missiles, artillery, mortars, Unmanned Aerial Systems (UAS / Drones), electronic warfare (EW) and decoys, and conventional fixed and rotary wing aircraft. The scenarios and vignettes analysis resulted in intuitive conclusions on the benefits of networked Fire Control Clusters (FCC) with dynamic management of services designed to counter these threat effects. The study concludes that the combined effects of interoperable dynamic fire control clusters is an imperative to maintain effectiveness, redundancy, and resilience under harsh combat conditions.

10	SG-265	23-Jun-22	NU	Interim report of NIAG SG-265 on Surface Based Air and Missile Defence (SBAMD) Survivability and Effectiveness in Joint and Combined Operations when faced by a Peer State Threat (Phase 1)	SG-265 Interim Report	During the first year of this two year study the SBAMD Key Perfomance Indicators (KPIs) and Key Performance Requirements (KPRs) have been developed and a methodoly devised for determining the KPRs required against a particular threat in specific environmental conditions. The electomagnetic spectrum (EMS) challenges have been considered and it has been determined that SBAMD will face challenges from a confined, congested and contested EMS. Proposals to mitigate these EMS challenges are being developed. The C2 architectures and supporting communications network architectures are being developed to support the needs for improved interoperability and integration leading to greater operational effectiveness in support of joint and combined SBAMD operations. The Study is also analysing what measures can be taken to improve SBAMD weapon system survivability and also the opportunity to apply technology or change processes to reduce the SBAMD human resource requirements. Finally, the opportunities to experiment, demonstrate and exercise the Study proposals will be detailed in the Final Study Report. The Study Group is due to present its Final Report in June 2023.