Royal Academy of Engineering

Government Office for Science

UK Intelligence Community Postdoctoral Research Fellowships 2024

Applicant guidance notes

Deadline 23 April 2024

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Introduction

The Government Office for Science offers UK Intelligence Community (IC) Postdoctoral Research Fellowships to outstanding early career science or engineering researchers. These Research Fellowships are designed to promote unclassified basic research in areas of interest to the intelligence, security, and defence communities. The National Protective Security Authority, Department for Transport, Defence Science and Technology Laboratory, Home Office, the National Cyber Security Centre, and UK National Authority for Counter-Eavesdropping are among the organisations represented in the UK Intelligence Community for this scheme.

Each year members of the IC identify research topics and the Research Fellows work locally with their University Research Advisor to develop and submit research proposals that align with the topics.

The research is conducted by the Research Fellows while working in partnership with the University Research Advisor and collaborating with an advisor from the Intelligence Community (IC Advisor).

The IC Advisor is the government representative for each topic. They are the responsible party from the government to track that the research of the UK IC Postdoctoral Research Fellow is in line with aims of the research topic.

The Research Fellowships are aimed at early career researchers from all branches of science and engineering who have up to five years postdoctoral experience. Only citizens of Australia, Canada, the EEA, New Zealand, Switzerland, the UK or the US can apply.

Each application for the UK IC Postdoctoral Research Fellowships is capped at a maximum contribution from the Royal Academy of Engineering (the Academy) **£250,000 over the 2-year period**, at 80% of the full economic costs (fEC). Research Fellowships must be held at a UK higher education institution/university.

Diversity and inclusion

The Academy is committed to diversity and inclusion and welcomes applications from all underrepresented groups across engineering. It is the Academy's policy to ensure that no applicant is disadvantaged or receives less favourable treatment because of age, disability, gender reassignment, marriage and civil partnership, pregnancy and maternity, race, religion or belief, sex, or sexual orientation.

Access Mentoring support

The Academy aims to provide additional support to applicants from groups that are persistently underrepresented within UK engineering through the grant application process. This positive action will contribute to improving diversity in the talent pipeline and widening the diversity of applicants and awardees within the Academy's research grant schemes.

To be eligible for Access Mentoring support, applicants must meet the eligibility criteria of the UK IC Postdoctoral Research Fellowships scheme and must be either:

- **women**
- **Black people, including those with any mixed ethnicity with Black ethnic background(s)**
- **disabled people**

The Academy accepts applicants' self-declaration on the above identified underrepresented groups under the host institution's guidance.

Access Mentoring is a resource limited opportunity. Applicants do not need to wait until the deadline to submit their application and can be matched with a mentor as soon as the application is approved. Early submission is encouraged. For more information on Access Mentoring please see the guidance.

Part-time and flexible working

The Academy wants to support applicants to achieve a balance between their personal and work demands, and is happy to discuss individual requirements and consider part time and other flexible working arrangements.

UK IC Postdoctoral Research Fellowships can be held part-time, but **must be the only form of employment.** Requests for a part-time Research Fellowship (at no less than 50% of full-time equivalent) must be clearly stated within the application. Alternatively, the Research Fellowship can be converted from full time to part time, or from part time to full time, during the fellowship, assuming the host institution supports the request.

Research Fellows are entitled to maternity, paternity and adoption leave under the host institution's normal conditions of employment. The Academy will extend the duration of the Research Fellowship pro-rata to take into account such periods of leave and any conversions to part-time working. Research Fellows with caring responsibilities should liaise directly with the host institution if they wish to apply for part-time or flexible working.

Submission deadline

There is one application round each year. The online application system for 2024 round will open in December 2023. The submission deadline for the 2024 round will be **4pm (UK local time)** on **Tuesday 23 April 2024**. Applicants will be informed of the result in July 2024.

Policy on National Security-Related Risks

The Academy is the UK's National Academy for engineering and technology and seeks to increase the potential positive benefit that innovations can have for society, whilst reducing the risks of harm. Hence, in all our activities, we seek to minimise the risk that technology developed as part of work that we support could be misused by a foreign state to build a capacity to target UK interests in a hostile fashion or to control or repress their population. There is a risk that for some grant activities, failure to protect IP and a lack of due diligence into collaborators could result in sensitive technology being transferred to and misused by a hostile or repressive foreign state. As such all applicants should ensure they are familiar with the Academy's Policy on National Security-Related Risks.

Eligibility criteria

1. UK IC Postdoctoral Research Fellowships must be held at a UK higher education institution/university in a department that can show it is capable of fully supporting the research project and researcher.
2. The applicant must be a citizen of Australia, Canada, the EEA, New Zealand, Switzerland, the UK or the US. The host institution is responsible for securing all necessary work permits and related costs for the UK IC Postdoctoral Research Fellows.
3. There are no age restrictions for applicants.
4. A basic security check is required as part of the UK IC Postdoctoral Research Fellowship scheme. By applying to this scheme the applicant is agreeing to be security checked prior to the start of the Research Fellowship providing the required information (full name, date of birth, nationality and current address) to the funder/relevant governmental organisation who will perform the check. If the Research Fellow does not meet or complete the security check, the UK IC Postdoctoral Research Fellowship award will be withdrawn.
5. The proposed research project must address one of the research topics outlined at the end of this document.

6. IC Postdoctoral Research Fellowships are aimed at early-career researchers. Applicants must have a PhD, which was awarded no more than **five years** before the submission deadline: **Tuesday 23 April 2024**. This period includes applicants' work experience in academia or/and in industry in the UK or/and worldwide. A margin of up to three months more than the five-year limit is acceptable. If applicants have had maternity/paternity leave or other extenuating circumstances (e.g., extended sick leave, national service, or caring responsibilities), this will be taken into consideration if the relevant dates and details are provided in the application form.
7. PhD students are eligible to apply, but must have been awarded their PhD (or the PhD has been unconditionally approved) before **1 August 2024** or the offer will be withdrawn.
8. The applicant must not hold a permanent academic position before the start of the UK IC Postdoctoral Research Fellowship. Probationary or fixed-term lecturers are eligible to apply if the probationary or fixed-term status remains till the start of the Research Fellowship.
9. UK IC Postdoctoral Research Fellowships must begin between **1 October 2024** and **1 December 2024.** The duration of a UK IC Postdoctoral Research Fellowship is two years full-time, calculated on a pro-rata basis for part-time awards. Requests for a shorter UK IC Postdoctoral Research Fellowship are not accepted.
10. UK IC Postdoctoral Research Fellows will be employed by the host institution and are required to devote all their working time to the Research Fellowship programme of work. The UK IC Postdoctoral Research Fellowship must be the Research Fellow's only source of employment. The Research Fellow should be based at the host institution for more than 50% of the Research Fellowship. If the Research Fellow needs to work more than 50% of the Research Fellowship outside the host institution, justification must be provided in the application form (Choice of host institution).
11. Applicants who have applied to this scheme before and were unsuccessful are eligible to reapply. These applications will be considered as new applications.
12. Occasionally security vetting is required as part of the UK IC Postdoctoral Research Fellowship scheme, by applying to this scheme the applicant is agreeing to be vetted if it becomes necessary during the Research Fellowship. If security vetting is required and the Research Fellow does not meet the security vetting requirement or does not complete the vetting process in a timely manner, the UK IC Postdoctoral Research Fellowship award will be withdrawn.
13. To assist with subsidy control compliance you must confirm whether your research project is either a piece of non-economic scientific research (with or without commercial collaborators) in terms of the Statutory Guidance on Subsidy Control clause 15.33 or an Industrial Research project with identified commercial collaborator(s). More info available in section 4 within the application form.

New Eligibility Requirement: nationality restrictions and basic security checks are now required by the Government Office for Science. This is to mitigate risks in the researchers' relationships with UK government and to safeguard awardees. Nationality is a protected characteristic under the Equality Act 2010, however exceptions for the purpose of safeguarding national security are permitted.

We remind you also that:

- UK IC Postdoctoral Research Fellowships cannot be jointly hosted by multiple institutions.
- It is the applicant's responsibility to contact the host institution to gain their formal approval before submitting an application.
- Any applications that are incomplete or do not adhere to the guidance will be rejected.
- Once submitted the application form cannot be edited and updated.
- As part of this grant application process your name and email address will be provided to the funder/relevant governmental organisation collaborating on the project to perform the required basic security checks.

Mentoring and monitoring

Awarded IC Postdoctoral Research Fellows will work with the Academy to identify an Academy Fellow to be their mentor. The mentor will provide expert, independent advice, and support for the duration of the Research Fellowship and will also formally monitor the Research Fellow's progress for the Academy. In addition, UK IC Postdoctoral Research Fellows will be assigned an Intelligence Community Advisor (IC Advisor), who will advise the awardee and the University Research Advisor on the research project.

UK IC Postdoctoral Research Fellows must submit a progress report every three months throughout the duration of the fellowship as well as an annual report and expenditure statement at the end of each year. At the annual review meeting the Research Fellow, mentor and Academy staff will discuss the report, progress made and future plans. Research Fellows will also be asked to provide some key data on their annual performance (e.g. publications and additional research funding) for the purpose of auditing and reporting to the Academy's funders.

The UK IC Postdoctoral Research Fellow will be invited to attend the US Annual Intelligence Community (IC) Tech Week during the period of the Research Fellowship.

Duration

UK IC Postdoctoral Research Fellowships are for a two-year period with an evaluation after the first year. If the project warrants a third year of research and the Research Fellow, University Research Advisor, and IC Advisor concur, the Research Fellow is required to submit a supplementary research proposal. The proposal should not exceed three pages and must be emailed to the Academy no later than 1 January of the second year of research. This submission does not replace the annual reporting requirement. The third-year extension will be based on the quality of the research proposed and the availability of funding.

How to apply

All applications must be submitted by the applicant themselves via the Academy's online Grants Management System (GMS), available at https://grants.raeng.org.uk

All applicants must first register and provide some basic log-in details to create a profile. Before completing the application form, applicants are asked to complete a **Diversity Monitoring Form** to help the Academy monitor and assess its diversity and inclusion policy. The information will be treated as strictly confidential, non-attributable and only reported when collated. It is gathered, stored, and used in compliance with the Academy's Privacy Notice in line with the General Data Protection Regulations 2018. The information will only be used for statistical purposes with access restricted to staff involved in processing and monitoring the data. It will not be seen by anyone involved in any selection processes. No information will be published or used in any way that identifies individuals. The Academy will retain personal information as per our Data Retention Policy.

The application form has seven sections and should take approximately one hour to complete, assuming you have answered the questions offline and merely need to enter the information, rather than compose it. To compose the application in its entirety will take significantly longer.

Many of the questions have prescribed word limits, which are designed to keep answers focused and give applicants an indication of the level of detail required. In such cases the number of words used will be displayed beneath the question and updated in real time.

Applicants can download a pdf of their application after submission, which is recommend for reference. There is only one application stage and those meeting the eligibility criteria will enter the assessment stage.

Guidelines on the use of generative AI

1. **Taking Responsibility for Content:** Applicants are fully responsible for all the content presented in their grant applications. The grant process does not penalise the use of generative AI tools, but it is imperative to ensure that the application reflects the applicant's own voice and ideas. For applicants whose first language is not English, machine translation may be used, but care should still be taken to ensure the accuracy of this translation, especially for technical vocabulary.
2. **Rigorous Approach:** Applicants should exercise caution when using generative AI tools to avoid the inclusion of 'hallucinated' references or factual errors. These often become more common when up to date content on a very specific topic is required, which is typical for most of our application areas. Such inaccuracies will be perceived as indications of a lack of rigor and will negatively impact the assessment of the application.
3. **Partial Use of AI Tools:** It is not acceptable to solely rely on generative AI tools to write the entire grant application from start to finish. While these tools may be used to assist in various aspects, the application must primarily represent the applicant's own work.
4. **Plagiarism Considerations:** Applicants should be aware that the output generated by some AI tools may utilize ideas from other human authors without proper referencing. As this is considered a form of plagiarism, it is essential to ensure that all sources are appropriately attributed.
5. **Proper Acknowledgement of AI Usage:** Applicants must provide clear acknowledgement if they have used generative AI tools in the process of writing their grant applications. This includes disclosing the name of the tool used and describing how it was utilized. The following style should be employed for referencing:

   I acknowledge the use of [insert AI system(s), version number and link] to generate materials for background research, styling, proofreading, etc.

   I acknowledge the use of [insert AI system(s), version number and link] to generate materials that were included within my final assessment in modified form.

   If the applicant's home institution has an alternative preferred style, they should in general use the Academy's or seek permission in advance for variation.

6. **Applicant Declaration within GMS:** These will standardly include explicit statements that the ideas presented are the applicant's own and not plagiarised or containing intellectual property they do not have rights to use, and that all contributions have been appropriately referenced or credited including the use of any machine intelligence tools used in developing the application. An inaccurate declaration will be grounds for immediate rejection of the application and potentially exclusion of the applicant and their organisation from future opportunities. (Please see paragraph 3, Reviewer Guidance.)

Completing the application form

After logging into the GMS and selecting 'UK IC Postdoctoral Research Fellowships', you should be presented with the 'Instructions' window. Here you will see some general instructions on how to use GMS, as well as the seven sections of the application form listed below:

1. Applicant and institution details
2. Applicant profile
3. Project details
4. Subsidy control compliance
5. Resources requested
6. Statement of support and declaration
7. Marketing

You can save your work at any stage in the application process and return to it later. You can answer the questions in any order you like, so you can freely skip some sections and return to them later. **Please read the guidance provided in this document in detail before starting an application.** You should also ensure that you have all the necessary documentation to complete the application, such as a copy of your CV and supporting letters.

Once submitted the application form cannot be edited and updated.

1. Application and institution details

Q. Applicant name and contact details

Please provide your name and preferred contact details. You should also provide the details of the host institution where the UK IC Postdoctoral Research Fellowship will be held and confirm that this is the 'lead organisation'.

Q. Nationality

Applicants must be citizens of Australia, Canada, the EEA, New Zealand, Switzerland, the UK or the US. Select one of the options from the drop-down list. This section is not visible to reviewers.

Q. Security check confirmation

A basic security check is required as part of the UK IC Postdoctoral Research Fellowship scheme. If the Research Fellow does not meet or complete the security check requirement, the UK IC Postdoctoral Research Fellowship award will be withdrawn.

Please tick the checkbox to confirm you are agreeing to be security checked prior to the start of the Research Fellowship providing the required information (full name, date of birth, nationality and current address) to the funder/relevant governmental organisation who will perform the check. You are also confirming that you are aware that as part of this grant application process your name and email address will be provided to the funder/relevant governmental organisation collaborating on the project. This section is not visible to reviewers.

Q. Security vetting confirmation

Occasionally security vetting is required as part of the UK IC Postdoctoral Research Fellowship scheme, by applying to this scheme the applicant is agreeing to be vetted if it becomes necessary during the Research Fellowship. If security vetting is required and the Research Fellow does not meet the security vetting requirement or does not complete the vetting process in a timely manner, the UK IC Postdoctoral Research Fellowship award will be withdrawn.

Please tick the checkbox to confirm you are agreeing to be vetted if it becomes necessary during the Research Fellowship. This section is not visible to reviewers.

Q. Contact details of the host institution

Please provide the name and contact details of your host institution. if you are not currently employed by the host institution, you should also add your current employer. Please mark the host institution as the 'Lead Organisation'.

2. Applicant profile

This section requests details as to your suitability and eligibility for the UK IC Postdoctoral Research Fellowship. You will need to answer some general questions on your experience and upload your CV.

Q. What date was/will your PhD Certificate awarded?

Applicants must have a PhD, which was awarded **no more than five years** before the submission deadline **(23 April 2024)**. PhD students are eligible to apply, but must have been awarded their PhD (or their PhD has been unconditionally approved) before **1 August 2024**. Please enter the date your PhD Certificate was awarded or the date your PhD was unconditionally approved by the university. If you have not received your PhD yet, please provide an estimate of when it will be awarded or unconditionally approved. This section is not visible to reviewers.

Q. Extenuating circumstance (optional question)

If your PhD Certificate was awarded more than five years before the submission deadline **(23 April 2024)**, please provide details of the extenuating circumstances. Please cover any periods of maternity/paternity leave, extended sick leave, national service, part-time employment for caring responsibilities or other activity that you feel should be considered when assessing your eligibility for the UK IC Postdoctoral Research Fellowship. The Academy's decision on eligibility is final. This section is not visible to reviewers.

Q. Do you currently hold a permanent academic position?

Applicants must not hold a permanent academic position before the start of the UK IC Postdoctoral Research Fellowship. This section is not visible to reviewers.

Q. Applicant's CV

The format and content of your CV is left to your discretion, but should include a list of publications. You may wish to indicate which publications you deem most significant and include a link to any that are open access. You do not need to include contact details as these are included earlier in the application form.
Please do not include personal information (e.g., gender, date of birth, and nationality) in the CV. The CV must be uploaded in a single PDF and the file size should be less than 5MB.

Q. Applicant's most significant achievements

Please describe three to five of your most significant achievements in your research career. We would like to emphasise that all achievements and outputs are welcome and considered valuable to the Academy, not just peer-reviewed publications. Outputs also include, and are not limited to code, patents, spin-out companies, events, public engagement, and policy impact. Please briefly explain the significance of the achievement in a way that will explain it to a researcher from your discipline who may not be familiar with the latest work in the particular field.
500 words maximum

The Academy's research programmes are aligned with the principles of DORA. If research articles published in peer-reviewed journals are to be included in an application, we would therefore like to emphasise that the scientific content of a paper is much more important than publication metrics or the identity of the journal in which it was published.

Q. Impact of COVID-19 (optional question)

The Academy understands that the impact of the coronavirus pandemic on researchers and their work is varied. If you wish, please provide a summary of how the pandemic has affected your research profile development that reviewers and panel members should consider. Reviewers and panel members will be advised to take into consideration the unequal impacts that COVID-19 related disruptions might have had on individuals.

The impact can include, but is not limited to, the following examples: pause on experiments/research plans, reduced ability to work due to additional caring responsibilities, delays in publishing/submitting a key paper(s) (please note pre-prints can be included in your publications list).
500 words maximum

3. Project details

Q. Research topic

Select one of the research topics relevant to your application from the drop-down list. The research topics are outlined at the end of this document.

Q. Project title

The essence of the research should be captured in the title and should be as informative as possible. Please use **no more than 10 words** and ensure that it is **understandable to a non-specialist reader.**

Q. Abstract

Describe the research in terms that can be understood by a non-specialist reader. What similar research is being/has been undertaken nationally and internationally, and how does your project differ.
300 words maximum

Q. Statement of problem

A brief outline of the basic facts of the problem, explain why the problem matters, and pinpoint a solution as quickly and directly as possible.
200 words maximum

Q. Background and relevance to previous work

Sufficient details should be given in this discussion (1) to make clear what the research problem is and exactly what has been accomplished; (2) to give evidence of your own competence in the field; and (3) to show why the previous work needs to be continued.
1000 words maximum

Q. General methodology

Please provide a detailed description of the exact work to be completed. Describe the programme of work, indicating the research to be undertaken and the milestones that can be used to measure progress. Detail the methodology to be used in pursuit of the research and justify this choice. What similar research is being/has been undertaken nationally and internationally, and how does your project differ?
1000 words maximum

Q. Explanation of new or unusual techniques

If you are using any techniques that are not standard in the area of the research proposed, please explain the technique and the rational for using it.
500 words maximum

Q. Expected results and their significance and application

Describe what you expect to get out of the research. It should join the data analysis and possible outcomes to the theory and questions that you have raised. Summarize the significance of the work and proposed applications.
1000 words maximum

Q. Project timeline

Upload a Gantt chart or equivalent to show the schedule of activities for the duration of the UK IC Postdoctoral Research Fellowship. Please ensure major milestones are clearly plotted. You may wish to include a diagram showing how the work packages and your collaborations – if any - will interact. **The chart/ diagram must be collated and uploaded as a single PDF.**

Q. Choice of host institution

Explain your choice of host institution. You may wish to comment on the facilities and local expertise that will be available to you. You should also cover what experience you have had and/or plan to gain from other institutions and alternative working practices. For example, any time spent on secondment or on extended visits.
200 words maximum

Q. Academy's strategic goals (optional question)

How do you align with the Academy's strategic priorities? Note this is not an assessment criterion and is for staff use only. We want to understand the extent to which our programmes as a whole meet our strategic aims, but your answer will not influence the decision and applications are judged purely on merit. The strategic plan is available on our website here. Select the answer that best describes the strategic aims your research will address:

- Sustainable society
- Inclusive economy
- Both
- Neither

Please give a short explanation for the answer you have selected.
100 words maximum

Q. Diversity and inclusion

The Academy strives to create cultures in which everyone can thrive, and we believe that diverse perspectives enrich our collective performance. What does diversity and inclusion mean to you and your research, and what are you and your team doing to address it? Consider your team, collaborators and universities, the implications on your research design and topic and the overall contribution this will have on your success.
250 words maximum

Q. Reference list

List the reference material referred to in your application. Where possible include web-links to any open access articles to help reviewers in locating the articles. You may want to highlight the most relevant ones.
700 words maximum

Q. Images and diagrams

Upload any images and/or diagrams related to your project that add value to your application. Any images/diagrams uploaded must be referenced in the application form. **The images/diagrams must be collated and uploaded as a single PDF** in the order you wish them to be viewed.

4. Subsidy control compliance

This programme most commonly awards grants on the basis that they are for non-economic research conducted without a collaborating commercial organisation. However, should a research organisation declare that a commercial organisation is to gain a direct benefit from the project then the Academy would award the grant under the Streamlined route for RD&I (SC10780) on the basis that it is an **industrial research** project that represents an indirect subsidy to the commercial organisation. The Academy will **not** fund projects that would be classified as be **feasibility studies** or **experimental development** projects as defined in the Research, Development and Innovation Streamlined Subsidy Scheme guidance.

Should the project be classified as an Indirect Industrial Research project and subsequently awarded as an indirect subsidy to the collaborating enterprise then the Academy will need to seek assurances about the level of funding already received by that commercial organisation in respect of the project to ensure compliance with the cumulation rules of the streamlined route, and ensure that funding for that project has not nor will exceed the £3M cap by awarding of the proposed grant. Per the streamlined route, the subsidy ratios allowed for an Industrial Research Project are: 85% for small enterprises, 75% for medium-sized enterprises, and 65% for large enterprises with the enterprise required to commit to, and demonstrate input at, the required level to comply with those ratios i.e. if the Academy awarded 85k for a Grant and the collaborating commercial organisation was a small enterprise they would be required to commit and evidence on request the required input 15k of funds for eligible costs under the streamlined route.

The eligible costs for all industrial research projects must align with the allowed costs per the **RD&I Streamlined route** and can include: personnel costs: the costs of researchers, technicians and other supporting staff to the extent employed on the project; costs of instruments and equipment, to the extent employed on the project; costs of buildings and land, to the extent and for the duration period used for the project; costs of conducting research and of external consultancy and contractual research or other knowledge assets, including patents bought or licensed from outside sources, and any other project operating costs and project overheads; including costs of materials, supplies and similar products, incurred directly as a result of the project.

Where equipment and instruments are not used for their full life for the project and have a useful life or residual value beyond the period of the project then the residual value should be deducted when calculating the eligible costs. In the case of small and medium enterprises (SMEs) the remaining value of new equipment and instruments purchased for the project may be a fully eligible cost providing they are used for the rest of their useful life after the project for research, development and innovation activities and to improve research, development and innovation capability.

This section is not visible to reviewers.

Q. To assist with subsidy control compliance, please confirm whether your research project is either:

a) a piece of non-economic scientific research (with or without commercial collaborators) in terms of the Statutory Guidance on Subsidy Control clause 15.33 "Non-economic scientific research may be carried out in collaboration with commercial organisations, as long as the commercial organisation does not receive a specific benefit from the financial assistance given to the research organisation. This would be the case, for example, where the commercial organisation pays the full cost of the project; or where results that do not give rise to intellectual property rights may be widely disseminated and where any intellectual property rights arising from the project are allocated to the organisations involved in a manner which reflects their contributions (i.e. intellectual property rights resulting from the activities of the research organisation are fully allocated to it). The commercial organisation is also unlikely to benefit if the research organisation receives compensation equivalent to the market price for the intellectual property rights which result from their activities."

or

b) an Industrial Research project with identified commercial collaborator(s) ("Industrial Research means the planned research or critical investigation that is aimed at the acquisition of new knowledge and skills for developing new products, processes or services; or that is aimed at bringing about a significant improvement in existing products, processes or services"). For more details, see RD&I Streamlined route guidance 14.3.

Select the option relevant to your application from the drop-down list.

Q. Are you collaborating with a commercial organisation on this project?
If your answer is 'Yes', then you need to reply to the following questions.

Q. How many commercial organisations are you collaborating with?
Please state the number.

Q. Can you confirm that when working with that commercial organisation(s) that results that do not give rise to intellectual property rights will be available to be widely disseminated and that any intellectual property rights arising from the activities of the research organisation fully allocated to it?
If yes, this should also be confirmed by the Recipient Organisation in their support letter.

If your answer is 'No', the grant may be a subsidy and the Academy will need to review the particulars of the benefits to the commercial organisation(s).

In the event the grant is deemed to be a subsidy, further investigations will need to be carried out to ensure we comply with funder regulations.

5. Resources requested

Applicants must consult with the host institution for support in completing the costs table. Please ensure that you allow plenty of time for the host institution to prepare the costings. The below categories explain what costs should be included in your application. You must be able to demonstrate that the resources requested are justified and appropriate for delivering the proposed research.

Each application is capped at a maximum contribution from the Academy of £250,000 over the two-year period, at 80% of full economic costs (fEC). The host institution is expected to provide any shortfall from its own funds or other grants.

Q. Costs table
When completing the costs table, some of the cells are auto-calculated and all values submitted should be rounded up to the nearest pound. **Please do not show actual fEC in the costs table.** In the costs table, the total funding requested from the Academy cannot exceed £250,000 at 80% fEC (the actual costs at 100% fEC cannot exceed £312,500).

5.1 Directly incurred costs

Staff

The UK IC Postdoctoral Research Fellowship's aim is to support researchers at an early stage of their research career. Salary should be at a level commensurate with skills, responsibilities, expertise, and experience. It is expected that requested salary will be comparable to postdoctoral researcher or early-stage lecturer salary scale points. The Academy reserves the right to provide support at a different level if it is considered appropriate.

The Research Fellow's salary can be requested for a period of two years full time equivalent. Salary increments over the period of the Research Fellowship should be considered in the costs, but possible future pay awards should not be anticipated. **Please note that the Academy does not pay inflation and inflation should not be applied to the costs.** In addition, the Academy is not able to cover the costs of the apprenticeship levy on research grants. Salary costs do not need to be justified in the 'Justification of costs' section.

The UK IC Postdoctoral Research Fellowship may be held on a part-time basis if the applicant is employed part time (minimum 50%). Applicants wishing to hold the award on a part-time basis must state the % time in the 'Justification of costs' section and explain why part-time working is requested. The costs table should be completed as if for a full-time fellowship and costs will be adjusted accordingly if the award is offered.

Please note:

- No other staff salaries can be requested as part of a UK IC Postdoctoral Research Fellowship.
- The UK IC Postdoctoral Research Fellowship must be the Research Fellow's only source of employment. Research Fellows are required to devote all their working time to the Research Fellowship programme of work. Research Fellows are encouraged to apply for further funding. However, any additional funding must not result in a reduction in the Research Fellow's time working on the Research Fellowship and cause a delay in the completion of the UK IC Postdoctoral Research Fellowship.

Travel and subsistence

Travel and subsistence costs can only be requested for the Research Fellow and must be for activities directly related to the research project. Travel costs should be based on the most suitable, cost-effective and environmentally friendly form of travel. Subsistence costs should reflect the normal rates that apply in the host institution. Commuting costs for working at the host institution cannot be requested.

Costs for attending national and international conferences (including two visits to the US Annual Intelligence Community (IC) Tech Week) may also be included where such attendance will directly benefit the research project. Conferences should, as far as possible, be individually identified in the proposal with attendance costs and fees fully justified in the 'Justification of costs' section.

Other Costs

Other costs should be specified and justified in the 'Justification of costs' with details provided in terms of their requirement for the research project. Examples include purchase or hire of small items of equipment, computer software licences, cloud computing/compute time at external facilities, laboratory consumables, purchase of specialist publications, open access costs, publication/printing costs, professional membership subscription fees or training costs.

Unless the need for significant computing power can be justified, the costs requested from the Academy for the purchase of a computer should not exceed £3,000 (including VAT), and no more than one computer should be requested over the duration of the UK IC Postdoctoral Research Fellowship.

The cost of any single item of equipment, software, cloud computing/compute time fees, database subscription or upgrade to existing equipment, requested from the Academy should not exceed £10,000 (including VAT). Should any piece of equipment include multiple separate items that are purchased individually and then combined to make a single functioning system, the cost of the entire system requested from the Academy should not exceed £10,000 limit.

Costs for major facilities not owned by the host institution, such as those supported by STFC, cannot be requested. If such facilities are required for the project, the applicant should contact the specific facility to determine access requirements. If access to a facility is essential to the research project, both access to and external funding for the cost of the facility must be secured within one year of the proposed start date of the UK IC Postdoctoral Research Fellowship.

Research Fellows are expected to make full use of any equipment that is available at the host institution and should therefore only request funding for equipment that is necessary and not currently available.

5.2 Directly allocated costs

Estates

Research Fellows may apply for estates costs for the duration of the UK IC Postdoctoral Research Fellowship. Estates costs do not require justification in the 'Justification of costs' section. Where the Research Fellow will be away from the host institution for six months or more in total, estates costs should not be requested for that period. In such situations, this should be confirmed in the 'Justification of costs' section.

Other directly allocated

Other directly allocated costs can be requested, calculated based on estimates and should be justified in the 'Justification of costs' section. Potential costs include the host institution's research/technical staff whose time is shared across several projects and charge out costs for existing equipment owned by the host institution, for example access to departmental SEMs and analytical facilities. Salary costs for specific technicians cannot be requested, costs for pool technician time for the use of facilities/equipment at the host institution can be requested.

5.3 Indirect Costs

Indirect

Please consult with your host institution for guidance as to these costs. Research Fellows may apply for indirect costs for the duration of the UK IC Postdoctoral Research Fellowship. Indirect costs do not require justification in the 'Justification of costs' section. Please refer to the efficiency savings published by RCUK in March 2011 when submitting your figures for indirect costs.

Q. Justification of costs

Please provide a narrative description of what resources are being requested and why. Ensure you have adhered to the guidance provided for allowable costs as detailed above. The justifications should include:

- all necessary justifications for costs included in the costs table
- to what extent the equipment requested will be used by other researchers and what equipment you are not requesting funding for (or for which you are requesting funding at a reduced rate) because suitable equipment is already available to you
- what costs will be covered by other sources, for example industry or existing grants, so are not being requested as part of the application
- if relevant, an explanation of why you wish to work part time and at what rate.

500 words maximum

6. Statement of support and declaration

This section seeks confirmation that the applicant has provided accurate information and will update the Academy of any material changes, which may affect the award. It should also confirm that the host institution will support the UK IC Postdoctoral Research Fellowship. You must upload all the additional documentation as explained below and then tick the box confirming the information provided is correct. **The submission deadline will not be extended due to an individual's unavailability.**

Q. Research Advisor's statement of support

The University Research Advisor must provide a statement in support of the application and clearly states their role, responsibilities, and support for the duration of the UK IC Postdoctoral Research Fellowship. The statement should be a maximum of two pages on headed paper and signed.

Q. Research Advisor's CV

The CV must not exceed two pages, should be submitted in **a PDF and the file size should be less than 5MB.**

Q. Host institution letter of support

The head of department or school, pro-vice-chancellor or dean or director at the host institution must provide a statement in support of the application. The statement must be on headed paper and signed. The statement **should be a maximum of two pages** and address the following areas:

Suitability of the applicant

- quality of the applicant's research track record
- potential of the applicant to become a future leader in their chosen field
- potential to act as an ambassador and advocate for the research

Support and commitment from the host university

- alignment of the proposed Research Fellowship with university research strategy and priorities
- details of mentoring, resources and support that will be provided to the applicant, should the application be successful
- other activities the applicant will be expected to undertake
- detail of the career development support that the applicant will be offered
- details of how the host institution adopts a proactive approach in encouraging researchers from underrepresented groups in engineering, to apply
- evidence of the host institution's commitment to equality and diversity

Impact of COVID-19 on the host university's support

The host institution can use this letter of support to highlight the impact of the coronavirus pandemic on their support for the UK IC Postdoctoral Research Fellowship if they wish. Reviewers and panel members will be advised to take into consideration the unequal impacts that COVID-19 related disruptions might have on the host university's support for the Research Fellowship.

The Academy and the Government Office for Science expect the host institutions to be committed to and provide support that aligns with principles set out in The Concordat to Support the Career Development of Researchers and The Concordat for Engaging the Public with Research, and DORA.

Q. Host institution declaration

The host institution's declaration letter must be completed by an appropriate individual from the institution's research support office or equivalent. **The letter must be on headed paper and should carry the signatory's name, position, contact details**, and the institution's official stamp (if available). The purpose is to check that the host institution is in principle willing to host a Research Fellow, subject to contract. The letter must confirm the application has been approved by the institution and **must contain the wording given in the box below**, as well as any further remarks the host institution wishes to make. **Please note that the wording provided in the box below is specific to the UK IC Postdoctoral Research Fellowships scheme, and the wording is updated and different to previous rounds.**

On behalf of the host institution, I can confirm that I have read and accept the application guidance and other information regarding this award scheme, which is provided on the Royal Academy of Engineering's website. I also confirm that:

- The costs submitted in the application are correct and sufficient to complete the project as envisaged. Any shortfall in funding discovered after the award has been made will be covered by the institution, potentially through other grants.
- the applicant will be employed by the institution for the duration of the award.
- if awarded, the applicant will be given full access to the facilities, equipment, personnel, and funding as required by the application.
- The applicant's teaching, administrative and non-research duties will be restricted to enable them to dedicate their time to research.
- We are aware that the UK IC Postdoctoral Research Fellowships scheme has non-standard intellectual property rights (IPR) conditions relating to or resulting from the proposed research. If the proposal is recommended for funding, we will be ready to assess the IPR conditions in the offered award contract.
- I am authorised to approve the submission of applications for funding and confirm this application has successfully met the eligibility criteria and all our internal approval procedures.

Q. Letters of support (optional section, but this is your opportunity to demonstrate wider support for you and your project)

Each letter of support must:

- be on headed paper and clearly state who they are from
- be from external collaborators i.e., people and organisations NOT working at the host institution and its affiliates
- be signed
- confirm that the author knows the applicant
- explain why they are interested in the project
- provide details on what form the collaboration will take.
- clearly demonstrates the nature of the collaboration and how it will be beneficial to the applicant and the project
- **be no more than two pages.**

Aim for quality over quantity. Shorter, more concise letters better enable the reviewers to identify the salient information. A bullet-point list of contributions can be an effective way to present the information.

The letters of support must be collated and uploaded as a single PDF.

Q. Applicant declaration

Please tick the checkbox once you have read and understood the declaration included in the application form.

7. Marketing

This section is optional, but helps the Academy to understand which of our marketing materials are most successful at reaching the academic community and helps us to improve our future communications work.

A grey '**submit application**' button will become available once the application form is completed.

Please note that once submitted the application cannot be edited and updated, but you may view it from your GMS account.

Assessment process and criteria

The scheme has one-stage assessment process. Applications will be assessed by reviewers consisting of the UK government intelligence, security, and defence community members (under the auspices of the Government Office for Science) and Academy Fellows. The reviewers will provide comments against each of the following assessment criteria, the overall quality of the application and make a recommendation on whether the applicant should be funded. The selection panel will consider the reviewers' comments and select the top ranked candidates for awards. To ensure both diversity and excellence, awards will be distributed across the different topics.

1. **Candidate**
   - quality of the applicant's research track record.
2. **Research quality and vision**
   - quality of the applicant's research vision, relevance, and novelty of the approach to the chosen research topic.
3. **Impact**
   - the potential contribution of the research to the UK government intelligence, security, and defence community.
4. **Research environment**
   - quality and level of support and commitment from the University Research Advisor and the host institution to complete the research fellow's research project and support their career development.

Declaration on Research Assessment (DORA)

The Academy's research programmes are aligned with DORA, which is a set of principles aiming to improve the ways in which the output of research is evaluated by funding agencies, academic institutions, and other parties. The outputs from research are many and varied, and as a funder of engineering research the Academy needs to assess the quality and impact of these outputs in order to make awards. It is imperative that research output is measured accurately and evaluated wisely.

In the assessment of research output, we would like to emphasise that all outputs are welcome and considered valuable to the Academy. Outputs can include open data sets, software, publications, commercial, entrepreneurial, or industrial products, clinical practice developments, educational products, policy publications, evidence synthesis pieces, and conference publications. With regard to research articles published in peer-reviewed journals, the scientific content of a paper is much more important than publication metrics or the identity of the journal in which it was published.

We value and appreciate the time and effort that reviewers give to support our research programmes. A good, helpful review for the Academy is one that assesses research on its own merits rather than by surrogate measures, such as on the basis of the journal in which research is published.

Why applications are unsuccessful

The most common reasons applications are unsuccessful:

Topic	The proposal does not meet the chosen research topic and requirements.
Track record	Applicants' research track record is not strong and relevant to the chosen research topic.
Collaboration	Unclear on potential collaborator plans including industrial/ clinical collaborations and clear routes to impact and exploitation.
Competitors	Not knowing and acknowledging competitors.
Vision	Vision and ambition not clearly explained in line with the chosen research topic and requirements.
Novelty	Proposal lacking novelty, or not articulating how the proposed work will address the research topic.
Realistic	Unrealistic in terms of overstating potential impact. Also, milestones, resources, and the applicant's ability.
Support	Lacking strong letters of support from the host institution, University Research Advisor or industrial partner and potential collaborators.
Communication	Inconsistent/unclear information provided in the application form.

For all queries, please contact the Royal Academy of Engineering's research programmes team at research@raeng.org.uk

Research topics 2024

Topic 1
Exploration to determine the positioning accuracy of mobile devices using the 5G cellular networks

Unclassified key words: telecommunications, 5G, Location Based Services, LBS, spatial accuracy, 3GPP standards.

Unclassified research topic description, including problem statement:
There is a lot of speculation and theory on the internet about the spatial precision of the 3GPP 5G telecommunications standards. This topic is to explore, prove or disprove what is actually achievable (in terms of location accuracy of a 5G mobile device) in the UK when using similar technologies to those used by the UK telephone operators.

Unclassified example approaches:
Location Based Services in 5G introduce a range of possible capabilities. Since these are not yet deployed commercially and involve new interfaces and network functions to deliver these, two phases of work are being proposed to be carried out – the first is to carry out exploration of technology, capabilities and possibilities for user location presented by 5G and scope the second phase – operational use-case validation and scenario exploration for a rural and urban scenario.

Phase 1 – technology and capability exploration:

- Understanding the impact of the deployment of 5G Non-standalone (NSA) into existing telecoms networks, and the possibilities and impact for user location arising from the deployment of 5G NR cells over an existing 4G core network (as is being/will be deployed in urban and suburban environments).
- Testing the introduction of an LMF function into a 5G SA network and evaluating functionality and feasibility of use of LBS capabilities in the network, and compatibility with core network components for 5G SA networks.
- Identify supported modes of operation with available 5G radios (i.e. what location-based services can actually do today, based on the features implemented by radios today), compared with the 5G standards, and exploring the extent to which the location standards are actually implemented in 5G network equipment at present.
- Exploring handset support for location-based services, and 5G location capabilities more broadly (since not all handsets fully implement all areas of standards) and evaluating the possibility of device location through passive means, based on routine uplink traffic generated by the device itself and apps/operating system installed on it (which would remove the need for the handset to cooperate and provide reporting on its observations of the PRS position reference signals).
- Exploring potential afforded by a roll-out of small cells for user location, and what this could offer in urban settings.

- Exploring whether devices implement and send sounding reference signal (SRS) signals within their uplink transmissions if requested.
- Exploring the likely realistic precision of location in 5G, based on experimentation, to investigate claims of 3 to 5m location precision, and claims around height / "Z-coordinate" positioning, and identify and understand the technical requirements on a network and radios which would be needed to achieve these.
- Exploring what different radio technical choices may afford around user location, including the potential use of urban mmWave FR-2 radios, and massive MIMO, which both have potential to enhance location precision or better support Z-coordinate height in positioning.
- Understand what a "vanilla" 5G network is likely to yield by way of user location capability, before addition of "over-the-top" enhanced location technology which would need to be re-developed for a 5G core network.

Phase 2 – operational use-case validation and scenario exploration:

- For a rural scenario initially, based on the available 5G location capabilities which can be used, determining the accuracy of user location.
- For an urban scenario, carry out a similar test scenario, to assess the viability of relevant urban goals, including 3-dimensional positioning, and precision.
- Other use-case validation and scenario testing which may arise from the findings in phase 1 (i.e. different radio technologies, options arising from small cells, etc.)

Technical 5G location-based technology of relevance to phase 1 evaluation:

- Testing functionality of 5G LCS (location services) via LMF (location management function) for regulatory use-cases outlined in Rel 15 standards.
- NR Cell-ID support for coarse conventional location of devices and exploring manual options akin to eCellID in a 5G network where a mix or alternative of low and high frequency cells are available (to compare urban and rural scenarios based on basic RF signal strength data).
- Testing for MT-LR (mobile terminated location request) support, and ability to trigger deferred (i.e., triggered, UE available, periodic, area-fenced) location reporting via LMF.
- Bulk (multi-UE) support for device location requests via the LMF.
- Time difference of arrival (TDOA) location method support and accuracy.
- Round-trip time (and multi-base station multi-RTT) if supported and exploring requirements for time sync in networks to enable this to work.

- Angle of Arrival (AoA) and/or Angle of Departure (AoD) measurements if supported on beam-forming capable massive MIMO radios.
- Exploration of whether Es are implementing support for UE-based NR native position, privacy settings on devices (as these are implemented by vendors), and options for GNSS-based assistance on the location reported to the network.
- Exploration of uplink-based positioning, based on the UL-PRS, which uses the Sounding Reference Signal that is already transmitted by the handset – potentially establishing positioning beam pairs, and allowing for device location from an uplink signal, just based on a passive uplink signal. Exploring if devices transmit the necessary SRS, and whether this can be enabled via MAC layer control protocols.

Topic 2
Detection of deep fake videos with audio

Unclassified key words: AI, generative, deep fake detectors, video, audio, speech, multimedia.

Unclassified research topic description, including problem statement:
The rapid advancement in generative AI technology has brought many new opportunities for content creation, but at an expense that malicious deep fake content can be easily created and then distributed. In the coming years it is anticipated that deep fake video complete with audio will mature, bringing another wave of advancement but again opening another angle for malicious or manipulated material that can be distributed at large.

The pace of open-source research in generative AI makes it incredibly challenging to keep track. Such pace also means that specialist research tools are being packaged more quickly than ever into software applications accessible to almost anyone, and usually before protective processes and legal understanding can be put in place. Development of deep fake video with audio detectors will become an urgent necessity sooner rather than later.

The topic here is the desire for detection systems to both quickly check large quantities of video with audio, and conversely, to provide explainable techniques on a fine-grained level to provide assurance and likely provenance.

Unclassified example approaches:
Possible routes to develop detectors could include:

- Exploring existing deep fake detection video with audio challenges, considering participation, and understanding the benefits and limitations of such common systems.
- Investigating deep fake video jointly with audio detection as well as separate video and audio detection research.
- Review deep fake video with audio research identifying key methodologies to understand their limitations.
- Consider forensic angles where lighting, occlusions, and possible statistical artefacts as an explainable alternative to any automated countermeasures.
- Exploring use of identity recognition of deep fake videos with audio for detecting deep fake content.
- The choice of language and emotion, and whether it is consistent with the scene or not.

Topic 3
Distributed High Frequency Over-The-Horizon radar

Unclassified key words: HF radar, ionosphere, data assimilation, inverse problems, signal processing, multistatic, distributed RF, MIMO, Beyond-Line-Of-Sight, Over-The-Horizon Radar, OTH.

Unclassified research topic description, including problem statement:
Over-The-Horizon (OTH) radars operate in the High Frequency (HF) band (3–30 MHz) and exploit signal reflection from the ionosphere to detect and track airborne and surface targets at ranges an order of magnitude greater than is possible with conventional line-of-sight radars. More than half a century of international research and development in this area has resulted in the fielding of mature OTH radar systems capable of cost-effective early-warning surveillance over wide areas. In particular, the ability of OTH radar to persistently monitor remote geographical regions where microwave radar coverage is not feasible or convenient represents an important advantage of such systems. The high performance achieved by state-of-the-art operational OTH radar systems is the outcome of a great deal of theoretical and experimental research in the areas of ionospheric propagation modelling, hardware system design, intelligent resource management, and digital signal processing. The knowledge gained and shared through joint programs of international collaboration has played a key role in the deployment of successful OTH radar systems worldwide.

Current trends dictate that for several Intelligence Surveillance and Reconnaissance (ISR) applications, the requirement is to push the boundaries on distributed OTH radar. Conventional OTH radar use large transmitter antenna arrays (typically 100-200 metres long) and even larger receiver antenna arrays, extending to many kilometres. The arrays each comprise many antenna elements and evidently a conventional OTH radar cannot be considered to be mobile or easily relocatable. The transmitting and receiving systems are usually located 50 km to 100 km from each other to provide radio frequency (RF) isolation of the transmitter from the receiver. Although a conventional OTH radar is formally a bistatic radar, it can often be considered monostatic at typical detect and track ranges; consequently, a conventional OTH radar transmitter and receiver can only measure the speed of a target along the look direction.

The scope of this research topic is to innovate next-generation and generation-after-next distributive OTH radars which would give added performance advantages for ISR applications by providing proposals which could advance theoretical and experimental research in the areas of ionospheric propagation modelling, hardware system design, intelligent resource management, and digital signal processing.

Unclassified example approaches:

Distributed high frequency over-the-horizon radar system:

The invention relates to the technical field of radar systems, radio physics, and the like, and, in particular, relates to a distributed high frequency over-the-horizon radar system. The distributed high frequency over-the-horizon radar system comprises a shore-based high frequency ground wave radar netted subsystem, a fixed/mobile ground wave over-the-horizon radar subsystem in other forms (float type, vehicle-mounted and shipboard ground wave radar), a high frequency sky wave emission subsystem, an environment guarantee subsystem, a control subsystem, and a data processing subsystem. The distributed high frequency over-the-horizon radar system can work in a ground wave netted and sky-ground wave hybrid netted mode, by virtue of distributed ground wave radar netted and sky-ground wave integrated netted detection, breaks through the limit that the conventional ground wave radar only can be distributed along coastlines, obtains more comprehensive physical quantity information at the original signal level by organic integration and mutual complementation multiple work modes, can improve accuracy of detection on wind, wave and current to a greater extent, greatly improves detection range of the high frequency radar system, and realizes far-shore ocean dynamics elements detection and near-shore fine detection.

Research Paper:

The article raises the problem of fine tuning over-the-horizon radars with relevant information about the parameters of the ionosphere. To improve the accuracy of the radar, it is proposed to create a system of remote positions, which are ionosondes of vertical and inclined sensing. The results of the operation of such ionosondes serve to adjust the global model of the ionosphere. Thus, the quality of the radar is significantly improved, allowing us to more accurately determine the coordinates of air targets.

Topic 4
Detection of obscured forensic or biometric markers at crime scenes or from objects

Unclassified key words: forensics, DNA profiling, fingerprint analysis, human identification, attribution.

Unclassified research topic description, including problem statement:
Deposition of friction ridge detail and/or human DNA through skin barriers including disposable gloves, re-usable gloves, and other hand/skin barriers. Can forensic or biometric markers be visualized and/or identified from crime scenes /objects when such barriers are in place?

Deposited friction ridge detail (i.e., finger or palm marks) and human DNA are often recovered from crime scenes and/or objects, in order to assist with forensic investigations. The use of gloves and/or other physical hand/skin barriers may impede the recovery of friction ridge detail and reduce the amount of DNA deposited on a surface. Despite the use of a barrier, modern fingermark visualization techniques may be able to capture glove prints or possible friction ridge detail that could be used for forensic intelligence or evidential purposes. An evaluation of different glove types, textures, materials, and use methodology (e.g., double gloving) will provide important information on whether intelligence or evidential friction ridge detail can be recovered despite hand/skin barriers. There is also an opportunity to evaluate these types of barriers on their effectiveness in reducing touch DNA deposition.

Unclassified example approaches:
An artificial finger pad, previously developed at Dstl for Covid-19 transfer research, could be used to test deposition of glove marks onto a variety of surfaces such as polymers, metals, and porous materials. The finger pad allows for controlled pressure deposition and can be adapted to also be used with artificial and real human fingerprints to test deposition with gloves or other skin barriers. Similar mechanisms could also be used to test for deposition of DNA. This is only one example of an approach, with more in-depth studies using human volunteers being envisaged.

Topic 5
Countering deception in Intelligence, Surveillance and Reconnaissance (ISR) networks

Unclassified key words: Intelligence, Surveillance and Reconnaissance (ISR), sensing, situational awareness, deception, strategy, game theory, bayesian Inference.

Unclassified research topic description, including problem statement:
Military sensing and intelligence gathering is complicated by the fact that our adversary's objective is, more often than not, in direct conflict with our own. Adversaries will work hard to obscure their state and their intent from observers; they may also undertake activities designed to give a false impression of this state or intent, which could involve, for example, hiding, mimicking benign targets, manipulating signatures, or deploying decoys and countermeasures. All of this is designed to complicate our inference, and means any decision based upon the ISR picture we compile must be robust to such tricky activity.

Behaviour designed to confuse the ISR picture is not confined to a single domain or sensor modality, and techniques found in certain scenarios have analogues in others (e.g., radar jamming/optical dazzle). The IC is looking for methods of quantifying the effect of such deception, and furthermore to develop strategies to recover the information which has been obscured or changed. The ultimate goal is that decisions based upon an ISR picture should be robust to deceptive activity, or at least aware that deception has taken place.

Unclassified example approaches:
Deception of sensing can take many forms and occur in many situations. We are interested in general aspects of the problem space such that we may draw conclusions and provide mitigations in multiple domains (e.g., Air, Land, Space, Maritime) and across a full range of sensors (e.g., radar, electro-optical, sonar, text-based, social media, to name a small subset). We want research to build toward a mathematical description of the deception of sensors. This description should thereby point to development of strategies to counter types of behaviour designed to deceive sensors. This may begin from general-purpose human-centric theories of deception and specialise them toward sensing and inference, or it may build from models of sensors and target intent. Whichever way is chosen, the research must develop a general mathematical framework characterising multiple and varying types of deception. These may encompass hiding, dazzling, decoying, mimicking, inventing real and fake targets, repackaging, and distraction among many other examples. Solutions to single and overly specified problems are not of interest here.

We will not be prescriptive regarding solutions; all techniques are welcome. We are, however, looking for methods which can be engineered within future ISR and autonomous systems and will eventually deliver benefit to the intelligence community. Preference will therefore be given to research which shows strong potential for exploitation in this direction. Cross-disciplinary research is encouraged.

Current component methods of sensor counter deception research cover modelling of intent, efficient optimization, game theory, Bayesian inference, scalable inference on graphs, and high-dimensional sampling methods. This list is neither complete nor prescriptive.

Topic 6
Flexible solid-state batteries

Unclassified key words: energy storage, batteries, Li-ion, solid state, flexible, wearables.

Unclassified research topic description, including problem statement:
Solid state batteries are at a maturity where they are commercially available. This is typically limited to use in devices that require low power levels, such as wireless sensors (marketsandmarkets.com), this is due to higher resistance that is typically exhibited compared to Li-ion cells utilizing liquid electrolytes. There is significant research in reducing internal resistance, and if achieved could unlock a much greater market share in the EV market for example, as solid-state batteries are typically significantly safer to use than liquid electrolyte-based batteries and more energy can be packed into the same space.

Related to this topic, is the growth of wearable technologies and specifically flexible batteries that can enable wearable electronics (Deng and He, Energies 2023). This is still an emerging market and although there has been research in the area of flexible batteries, uptake in the commercial market has been limited (marketandmarkets.com).

By combining developments of solid-state batteries, and flexible batteries, it is believed a viable battery could be developed for the wearables market that can store significant amount of energy and have increased safety for the user. There have been developments in flexible electrodes by utilizing non-metallic current collectors, printed materials and increasing binder content, but there is a lack of research on developing the solid electrolyte/separator material that can also offer a degree of flexibility.

Therefore, this research topic should focus on developing and proving that a solid-state electrolyte can be manufactured which can also be bent and flexed and is appropriate for use in a wearable scenario.

Unclassified example approaches:
Early approaches to solid-state batteries have been demonstrated using solid polymer electrolytes (SPEs) or inorganic solid electrolytes (ISEs) based on sulfides or oxides. They often suffered from low rate due to poor ionic conductivity or poor electrochemical stability compared to liquid electrolytes. The rigid structures also required high levels of compression to ensure good electrical contact to suppress lithium dendrite growth during extended cycling. These requirements are incompatible with wearable or flexible structures and so a new approach is required.

Recently, hybrid systems have been created that benefit from the increased ionic mobility of a solvent trapped in a polymer, such as hydrogel electrolytes (Xin Li, *Chem. Eng. J., 2022*). However, these formulations can be semi-solids / quasi-solid-state and so require thick layers or separators. The structures can provide higher performance and flexibility but rarely are evaluated using wearables and accept lower operating voltages to overcome limited environmental protection.

Other approaches avoiding liquids have included blending the polymer and ceramic together through either a polymer in ceramic or ceramic in polymer structure (Kun Zhang, *Adv. En. Mat., 2022*). They often will have extremely strong structures but suffer from lower ionic conductivity. These demonstrated a secondary benefit of the electrolyte providing an environmental protection layer in addition to active electrolyte.

Flexibility has also been achieved by imparting the ISE into a fabric-based substrate (Yunhui Gong, *Materials Today, 2018*). The addition of carbon conductive additives and more flexible anode/cathode elements has further refined this approach (Changmin Shi, *Energy Storage Materials, 2023*). Hierarchical designs can enable the sharing of physical properties and enable the use of rigid ceramics into a woven structure that is perfectly adaptable to wearables.

The flexibility can also be gained from utilising thin structures, such as drawn fibers. A team at MIT demonstrated that multi-layered structures of battery elements could be drawn simultaneously to achieve a fiber battery (Tural Khudiyev, *materials today, 2022*). This extremely thin structure wouldn't necessarily require the flexibility of a classical sheet electrode due to the narrow structure. The design will struggle with stress and strain if using inflexible elements but shows a novel approach.

Topic 7
Detection of genetic engineering and/or Synthetic Biology

Unclassified key words: genetic modifications, synthetic biology, biosecurity, detection, attribution.

Unclassified research topic description, including problem statement:
The timely detection and identification of a biological hazard is critical to minimizing the impact of an event, whether that be a natural event (e.g., emergence of a new viral strain such as SARS-Cov-2) or a nefarious release (e.g., intentional dissemination of material such as the Amerithrax attacks). Microbial forensics represents a new and emerging area of science which goes further than simply detecting an organism is present in a sample, by determining the material's provenance and whether there are any signatures of nefarious release (e.g., evidence of laboratory growth, changes in the genome). The identification of genetic modifications (GM) of an existing pathogen and/or the creation of new organisms with the potential to be pathogenic to human health represents key attributable intent (i.e., nefarious). Approaches that enable the detection of these signatures will therefore be crucial to improving government preparedness against the misuse of GM and/or SynBio microorganisms.

The detection of the use of GM and/or SynBio represents a significant technical challenge. Traditional bioinformatics tools that interrogate genome sequencing data are limited with respect to the complexity of data that can be analysed (e.g., cannot interpret metagenomic data) and often require significant lengthy onward human intervention (e.g., lack automation, AI). New bioinformatics approaches are required – potentially involving artificial intelligence and data science fusions – in order to interpret complex genomics data and also identify the presence of genetic engineering.

This proposal seeks the generation of completely new approaches to this problem, benchmarking these newly developed techniques against traditional bioinformatics pipelines used in genomic analysis and demonstrating performance improvements with respect to the detection of the use of genetic engineering and SynBio.

Unclassified example approaches:

A possible approach may include:

- Assessing the current "market" with respect to bioinformatics tools that could be used for the intended purpose.
- The development of curated reference database(s) of signatures of genetic engineering and/or the use of SynBio.
- Bioinformatics tools and pipelines that can map genomics data (both DNA and RNA) robustly to publicly accessible reference databases and are able to screen for the presence of indicators of GM and/or SynBio.
- Provide graphic user interface (GUI) that provides a preliminary interpretation of the result and/or highlights areas of interest within the genomics data for furthermore targeted investigation.
- Use openly accessible reference genomes as training data sets to apply AI-machine learning techniques in order to improve the efficacy of the tools for identifying markers of genetic engineering and/or SynBio.
- Undertake performance tests using pre-existing genomics data in the public domain to demonstrate the robustness of the technique to separate between natural organisms and genetically engineered or synthetic organisms.

Topic 8
Anticipating complexity in a modern world

Unclassified key words: microbiome, biosecurity, detection, attribution, disease, engineering biology, synthetic biology.

Unclassified research topic description, including problem statement:
The world is becoming ever more complex as physical reality is combined with the virtual world of cyber through the cyber-physical. Interdependencies of cyber-physical system components, either directly or via the virtual world of computing, are growing in intensity. At some point in the future, the technologies we increasingly rely on to live safe and fruitful lives will become complex systems with emergent properties in their own right. Soon, our relationship with the cyber-physical systems that surround us will be determined by the emergent properties of the collective and will not merely be the sum of what the developers of the individual devices intended. This affects the availability and reliability of smart cities, intelligent transport systems, supply chain logistics, smart buildings, industry 4.0, advanced military conflict, and wherever large collectives of disparate technologies sustain our lives.

How do we predict the technological tipping point to complexity? How do we prepare ourselves so that we understand the security implications of technologies with properties no one intentionally designed? How stable will the environment we live in be, and how vulnerable to attack? These are just some of the questions we are likely to face in the next few years.

This topic is to explore the representation of complexity in highly interdependent collectives of cyber-physical systems. We can assume that each member of the c ollective is a heterogenous intelligent agent, or a member of a guild, with a model of its situation (and potentially those around it), but without visibility of the collective as a whole. Individual mission goals drive behaviour (which may be prosocial or antisocial) with no guarantee of synergy or collaboration. The research is to define fundamental approaches to modelling complex systems. This may include (but is not limited to) the evolutionary dynamics: coherence in time (synchronization and coordinated dynamics), adaptation, levers and lever points; thresholds; critical behaviours; tipping points; stability; turbulence; sustainability; susceptibility; and resilience. The emphasis is on the connected technologies of tomorrow and their behaviours from a cybersecurity perspective. The aim is to create a mathematical model of complexity in collectives of cyber-physical systems that will lead to better understanding of security vulnerabilities, the corresponding defences, and the potential impact of cyber-attack.

Unclassified example approaches:

- Models of complexity in intelligent agency (e.g., emergent properties of Popperian intelligent agents, antifragile systems).
- Agent-based modelling of multi-agent systems (e.g., stochastic modelling of multi-agent behaviour and interactions; swam intelligence models).
- Generative self-organisation (and Finitely Generated Systems).
- Measures of complexity, such as entropy; intensive or extensive measures (of how the properties changes when the size or extent of the system changes); behaviour (such as measures based on the law of requisite variety).
- Revealed Dynamics Markov Model (Bramson, 2019 in Carmichael et. al. pp79-128).
- Other mathematical tools of complexity science: branching processes (and generator functions), statistical mechanics, network theory (and graphs), information theory and entropy, stochastic dynamics (and probability), intermittent dynamics (and differences in dynamics at the individual and aggregated scales), and co-evolutionary dynamics.

Ted Carmichael (Editor), Andrew J. Collins (Editor), Mirsad Hadžikadić (Editor), Complex Adaptive Systems: Views from the Physical, Natural, and Social Sciences (Understanding Complex Systems), Springer; 1st ed. 2019 edition (27 Jun. 2019), ISBN-13: 978-3030203078.

Topic 9
Light weight metamaterial ultrawideband frequency absorber

Unclassified key words: metamaterial, absorber, ultrawideband, polarized, acoustic, RF, technical surveillance, novel materials, attenuation.

Unclassified research topic description, including problem statement:
Metamaterials have been widely used in the past few years for RF as well as acoustic shielding applications. These are typically only applicable over a limited bandwidth, and there has been limited research in the metamaterial absorber design for combined acoustic and RF application, from a few Hz up to 30 GHz. There are additional research gaps that RF absorption effects suffer from the incidence polarization of its signal, meaning that shielding often does not fulfill the requirements in the IC's scenarios, as outlined in the last section.

In this topic we would like to explore the research and development of novel light-weight metamaterial absorbers to provide the frequency absorption over a wideband range from a few Hz to 30 GHz that is insensitive to the incident signal phase.

The development would help in providing an absorption and attenuation of various sound and RF signals emanating from multiple consumer devices and sources and bring new vitality into traditional approaches.

For further related reading, please see the following references:

- Zhang et al., 2020, "Engineering Acoustic Metamaterials for Sound Absorption: From Uniform to Gradient Structures", iScience.
- Yang and Sheng, 2023, "Acoustic metamaterial absorbers: The path to commercialization", Applied Physics Letter.
- Begaud et al., 2018, "Ultra-Wideband and Wide-Angle Microwave Metamaterial Absorber", MDPI.
- Tirkey and Gupta, 2019, "The quest for perfect electromagnetic absorber: A review", International Journal of Microwave and Wireless Technologies. from doors, lifts, etc.).

Unclassified example approaches:

- Computational modelling and calculation of the architectural design.
- Model and simulate the behavior of metamaterial absorber for its intended frequency range.
- Identifying candidate materials and novel composite structures with negative permittivity and permeability, potentially using conductor and dielectric sandwich materials.
- Optimise the design for the physical construction.
- Experimental verification of the physical design and its analysis for its application.
- Development of lightweight design for its integration within a physical space.

Topic 10
Machine learning trained fingerprinting of the near field measurement

Unclassified key words: machine learning, fingerprint, near field, electromagnetic, EM, RF.

Unclassified research topic description, including problem statement:
Electromagnetic (EM) shielding controls have widespread usage ensuring secure communication facilities do not emanate unintentional EM signals. Over the past few years near field measurement has been obtained with traditional multiprobe technique in combination with analytical functional evaluation to provide a measurement of the complex and dynamic EM field, however this approach introduces uncertainties in its measurement result due to dynamic field complexity within its surrounding. Recent advancement in Machine Learning (ML) with linear/non-linear mapping algorithms has exhibited novel techniques to solve complex analytical functions in real-time.

This topic looks for the development of fast and efficient ML integrated near field measurement within a dynamic and complex EM environment to provide fingerprinting of its surroundings for secure communication.

Unclassified example approaches:
- Literature survey for the near field measurement of EM signals.
- Near field measurement of an EM surroundings.
- Development and application of the ML algorithms integrated into near field measurements.
- Real time measurement and response accuracy enhancement within a dynamic EM environment.

For further reading please see following references:
Wen, J et al., doi: 10.1109/TEMC.2020.3004251
Alavi, RR et al., doi: 10.1109/APUSNCURSINRSM.2019.8888868
Deschriiver, D et al., doi: 10.1109/TEMC.2011.2163821.

Topic 11
Analysis of non-western emerging technology

Unclassified key words: AI, engineering biology, telecommunications, semiconductors, quantum, quantum sensing, advanced semiconductor manufacturing, hypersonics, internet of things, smart cities, digital twins, machine learning, robotics, patents, roadmaps.

Unclassified research topic description, including problem statement:
We believe that the emergence of hostile technology may be predicted from the comparative volume of patents and research publications, and the amount of investment by certain countries, on specific areas of novel technology. The timeline of emerging threats may also be predicted by considering how multiple technologies could be combined.

There is an increasing concern of reliance on non-western science, technology and manufacturing. This growing reliance may mean the UK is less resilient to shocks in the market, could impact long-term economic growth, and position technology in some more sensitive equipment in the national security arena, out of our control.

A recent publication in March 2023, The UK Science and Technology Framework, highlighted five critical technologies to the UK. These were Artificial Intelligence (AI), Engineering Biology, Future Telecommunications, Semiconductors and Quantum Technologies.

We would like an IC Postdoc fellow to deep dive into the emerging technologies in non-western countries undertaking a systematic review. This will inform strategy, policy, and future investment in the five critical technologies highlighted.

Unclassified example approaches:
We believe a fellow with a strong strategy and policy background, as well as a broad understanding of the five critical technologies will be well placed.

The emergence and development of the five critical technologies could be predicted from a systematic review looking into volume and trends of patents, interdependency with other critical patents, research publications (including impact and number of citations), commercial developments, and open-source future roadmaps. It should also be considered how multiple emerging technologies could be combined and what these threats may be.

Example Approaches:

- Compare the total number of patents, research publications and grant funding by country on each type of technology, over a period of time, to infer what the emerging threats might be and their timeline.
- Analyse in detail the patents and research publications on particular types of technology to predict what the emerging threats might be and their timeline.

Topic 12
Detection of low volatile materials

Unclassified key words: detection, explosives, quantum, nanomaterials, sensing.

Unclassified research topic description, including problem statement:
The solutions implemented for bulk and trace detection of explosives and other related materials have matured to a sufficient point that they are now widely accepted as the gold standard within the field, being capable of high levels of sensitivity. A useful augmentation to the arsenal of detection solutions would be a portable vapour detection system with optimised selectivity and sensitivity required to work outside of a laboratory environment. Current gas sampling and analysis techniques – such as gas chromatography, mass spectrometry and ion mobility spectroscopy – when used in the vicinity of particular materials allow for detection at a satisfactory concentration level. Whilst sufficient, many of the techniques used could benefit from reduced operational costs, easier sample preparation, simplified useability, and reduced need for re-calibration.

Many threat materials either have low volatility or are concealed in such a way that the amount of vapour available to detect is minimal. As well as the challenges imposed by commercial and military grade explosives, the diverse chemistries of homemade explosives (HMEs) pose an additional challenge. The complex vapour signatures of HMEs are not only highly variable, but their compositions vary with time and environmental conditions which requires additional consideration. The techniques for explosives detection should be non-invasive and based on direct detection at the source.

The successful development of a portable system with high selectivity and the sensitivity needed would potentially find application in finding the location of an odour source, to not only classify the material of interest, but also search for the threat.

Unclassified example approaches:
The utility of a sensor is dependent on many parameters, the most important of which is sensitivity and selectivity, which have been the focus of much research to date. Currently available commercial sensors do not demonstrate the level of selectivity required but many novel sensors have the potential to improve performance. Functionalisation of receptor materials has demonstrated improvement in selectivity demonstrating the capability to characterise materials of similar chemical groups, but performance improvements in the presence of many interferents and continuous change in background (e.g., temperature and humidity) would be beneficial.

The focus of this project is to leverage emerging technology in novel sensing such as quantum sensing, polymers or nanomaterials which have the potential to enable sensors to reliably detect and identify tiny amounts of chemical vapours. The realisation of accurate sensing devices would have potential applicability in the early detection and identification of airborne threats.

Approaches should include experimental methods and, where possible, comparison to existing solutions.

Topic 13
Understanding AI enhanced biotechnology risks

Unclassified key words: PNT (Positioning, Navigation and Timing), CNI (Critical National Infrastructure), resilience, threats, risks, mitigation, emergency services, technology.

Unclassified research topic description, including problem statement:
The latest generation of Artificial Intelligence (AI) models have the potential for broad applicability across science, with an associated set of opportunities and risks (Birhane et al., Nat. Rev. Phys., 5, 277-280, 2023). For example, researchers have identified the risk of AI giving enhanced access to dual-use biotechnology tools like DNA sequencing and gene editing, with associated potential for misuse (O'Brien & Nelson, Health Secur., 18(3) 219-227, 2020).

Soice et al. 2023 (arXiv:2306.03809) present a case study investigating the possibility of Large Language Models (LLMs) being used to cause a pandemic, finding they could suggest potential pandemic pathogens to a user, explain how they could be generated from synthetic DNA, supply the details of DNA synthesis companies who might produce the pathogen, and troubleshoot possible problems.

Sandbrink 2023 (arXiv:2306.13952) discuss the risk from Biological Design Tools (BDTs) like RFDiffusion and ProGen2, suggesting they likely increase the ceiling of possible harm from misuse of biotechnology.

Unclassified example approaches:
The researcher will first perform a literature review of a) possible engineering biology security risks enabled by AI (both LLMs and BDTs, but also other model classes), and b) the current landscape of AI safety research, before conducting novel research to identify which security measures are most appropriate to biotechnology and bioengineering AI risks – this is a global problem and the researcher will be expected consider global perspectives and possible global solutions. Possible measures could include novel improvements to Reinforcement learning from human feedback (RLHF), different pre-release evaluation approaches, more reliable DNA screening methods, controlled access/ authentication for BDT use, but the researcher is encouraged to develop new approaches, anticipating how the field may evolve in the future.

Topic 14
Development of techniques to assess data aggregation

Unclassified key words: data aggregation, re-identification, de-anonymization.

Unclassified research topic description, including problem statement:
Problem statement: development of a methodology to enable identification and repeatable assessment of risks arising from the aggregation of data sets. This issue is becoming more acute due to the existing volume of published information about national infrastructure produced at the behest of policy makers and regulators, but without adequate consideration of the potential intelligence value to hostile actors and risks associated with these aggregated information sets.

It is recognized that data aggregation arising from combinations of data sets can result in revealing or allowing the inference of information that is not contained in the aggregated data. For data that may be linked to an individual or groups of individuals, it is difficult to measure re-identification or de-anonymization risks that may arise in ways that are both general and meaningful. For data relating to physical assets, it can be difficult to assess what can be inferred about the criticality or sensitivity of the assets and their associated infrastructure.

There have been several publicized examples of anonymized data being de-anonymized enabling the identification or re-identification of individuals and locations. At present there is no published guidance defining how to assess the potential consequences of data aggregation, nor are tools available that allow testing or formal evaluation of combined data sets prior to their publication or disclosure.

While there is some understanding of the issue in respect of personal and travel data, the concept is poorly understood with regards to asset data, particularly relating to infrastructure assets, where factors such proximity, interconnection, and interdependence can create criticalities. A complicating factor with infrastructure data is the need to understand not only the geospatial relationships but also the significance of facilitating the disclosure or inference of links between sensitive or potentially sensitive physical assets/sites and the infrastructure that supports them.

Unclassified example approaches:

Examples of potential data aggregation threats include:

- Identity disclosure – associating individuals with specific records and/or locations which may arise from insufficient de-identification, re-identification by linking data from two or more sets, or from pseudonym reversal.
- Attribute disclosure – identifying an attribute in a dataset held by a specific individual, group of individuals, or by asset(s) with high probability, even if the data associated with the targeted entities are not identified.
- Inferential disclosure - making an inference about an individual, group of individuals, location(s) or asset(s) with high probability, even if the targeted entities were not in the dataset prior to de-identification/anonymization.

The latest draft of NIST SP 800-188 - *De-Identifying Government Data Sets* (https://doi.org/10.6028/NIST.SP.800-188) provides some background to the issue and an extensive list of references. The proposed research would build upon this to develop methods and, where practical, tools to assist users to identify and address potential aggregation issues.

Topic 15
Utilizing a modern mobile to provide a level of TSCM capability

Unclassified key words: TSCM, mobile phone, tablet, discrete.

Unclassified research topic description, including problem statement:
Current Technical Security Countermeasures (TSCM) tools are various, expensive and a range of physical sizes. All of them together make a useful tool set, but there are operational challenges such as logistics, ease of use, and discretion that are presented in their application.

The modern mobile platforms – i.e., mobile phones and tablets – are a high specification computer processor with a variety of measurement and communications sensors and transducers. These can be exploited to measure the physical world and collect information and measurement data equivalent to the TSCM tools, in a single device.

We are looking to find out how the sensors on a mobile phone (accelerometers, cameras, magnetometers, vibrometers for example) can be used in conjunction with software defined radio to be useful as a tool in monitoring an environmental for technical threats, such as hidden electronic devices.

Key questions – can a phone be used as a TSCM tool to detect hostile threats? Secondly, how effective is that tool when compared to the specific equivalent TSCM tool. Additionally, what are the benefits of collecting data simultaneously and aggregating it at scale?

Unclassified example approaches:
- Downloading and comparing commercial applications for example wifi scanning and ranking for performance.
- Utilizing a bespoke overarching application to manipulate and leverage the commercial applications.
- Utilizing external peripheral devices to exploit sensing not native to the phone. Infrared camera, lenses, borescopes, microphones.
- Utilizing a bespoke overarching application to manipulate and leverage the commercial applications.

Topic 16
Simulation of emerging sensor technologies

Unclassified key words: edge, IoT, cloud, compute, neural networks, post-CMOS, machine learning, cybersecurity, green AI, sensors, emerging technologies, simulated environments, modelling, imagery, audio, magnetic, RF, motion, quantum sensors.

Unclassified research topic description, including problem statement:
Scientific and engineering advances in areas such as quantum, photonic and manufacturing techniques are creating opportunities for the development of new types of sensors which may create as-yet unquantified opportunities (and threats) for the IC trying to operate in environments where currents sensors are ineffective.

For most use cases traditional methods of gathering environmental data from the commercial world are very mature, such as light (imagery/photos/video), pressure (audio), magnetics (object detection), RF, and motion (accelerometers and gyros). Capability upgrades are mostly in the processing of the output, not the sensing itself.

There are however still several areas where current sensors fail to gather useful information:

- Non-illuminated ultra-low light imaging.
- Speech detection in high noise, highly reverberant environments.
- Position in GNSS-denied environments.

The aim of this research topic is to investigate the use of simulated environments to quantify/qualify the effectiveness of novel sensing methods in environments where current sensors are ineffective.

Unclassified example approaches:

- Create a scenario within a simulated environment, model novel sensor techniques and quantify.
- Using information on novel sensors that can detect faint objects, or detect without the photons even hitting the object.
- Gravimetry sensors used to passively detect objects underground.
- Increase sensitivity of GPS receivers.

We are not overly prescriptive as regards solutions; all techniques are welcome. We are, however, looking for methods which could be practically used as technique matures.

Topic 17
The influence of air quality on cognitive performance and behaviour in secure environment

Unclassified key words: carbon dioxide, building environments, cognitive performance, memory, decision making, psychology of security breaches.

Unclassified research topic description, including problem statement:
The Foreign, Commonwealth & Development Office (FCDO) owns a complex global estate of buildings. Each building has its own unique qualities and they are located in major cities where poor air quality is a factor. The buildings are designed in a way to maximize security and often overlook the human factors associated with their users and how these users interact with their workspace.

It is well documented (Lowe et al, 2018), that when human beings breathe in air with increased levels of Carbon Dioxide (CO_2), the CO_2 levels in our blood increases, meaning the blood is less oxygenated and this impacts how our brains function. In turn this can lead to poor memory, impaired concentration and reduces our decision-making capability. Current research has not examined the specific impact this may have upon analysts or individuals who work in security environments. Often the solution is not merely introducing air conditioning and other building information management systems to regulate these secure areas. We have not taken into account the impact of exposure to pollutants and poor air before we even arrive at our place of work.

We would like some empirical evidence to be gathered to demonstrate the impact of decision making and concentration on tasks of varying complexity in enclosed spaces where there are enhanced levels of CO_2 in the atmosphere. These tasks should be undertaken by individuals AND small teams. Ideally the activity should examine tasks that involve making decisions based upon written information AND more mobile activity such as conducting security inspections (and creating reports afterwards). We would also like to study whether there is an association between air quality and the number of security incidents, for example, people not adhering to the security protocols of a building and inadvertently causing security breaches. We would like to compare individual behaviour with that of group behaviour. We would be interested to know about any other airborne particles that could impact human performance in an office space.

The research will help us better design secure environments and provide optimal workspaces for individuals who spend prolonged periods in secure spaces. It will inform security policy and guidance.

Unclassified example approaches:

- Inhalation of air with increased CO_2 levels leads to poor cognitive functioning.
- The impact of pollution on human respiratory systems.

Possible future impacts of elevated levels of atmospheric CO_2 on human cognitive performance and on the design and operation of ventilation systems in buildings - Robert J Lowe, Gesche M Huebner, Tadj Oreszczyn, 2018 (sagepub.com).

Topic 18
Using homomorphic encryption for machine learning on sensor data and privacy

Unclassified key words: homomorphic encryption, machine learning, Internet of Things, sensors, privacy of data.

Unclassified research topic description, including problem statement:
The concern and need to protect data and privacy continue to grow. Over the years, fully homomorphic encryption (FHE) has emerged as a possible solution and offers defence mechanisms that allows computations to be performed directly on encrypted data while maintaining confidentiality. However, high computational complexity on large ciphertexts had limited the capability for FHE to be leveraged. To address these challenges, there is a need for cryptographic accelerators that can expedite real-world application deployment. Thus, the objective of this project is to design and optimize the homomorphic encryption algorithm to enhance data sharing and confidentiality.

To accomplish the research objective, there is a need to develop a framework that leverages the benefits of homomorphic encryption (HE), and machine learning (ML), to protect information during data collection and sharing process against potential attacks such as data collected from supervised devices such as sensors, network flow, and camera systems that are encrypted using HE schemes.
Machine learning (ML) as a cloud-based service is growing rapidly and the growth of Internet-of-Things data have given rise to a significant concern for monitoring systems while maintaining the security of data during ML inferences. Cryptographic accelerators may reduce the computational burden of homomorphic functions, enabling faster and more efficient computations on the encrypted data. The proposed approach will advance new theories and methods for effective and efficient defence processes involving homomorphic encryption, ML, and optimization of data sharing and privacy.

Unclassified example approaches:
Develop a software architecture for integrating FHE into networks to collect data from devices such as sensors and sensing and camera systems.

- Provide a proof-of concept by developing a small data base using the software architecture.
- Implement the software design using simulated or real sensor arrays feeding FHE data to an encrypted data base where ML operations will be executed.
- Deliver a report that compares the results to the same data created in an unencrypted environment and demonstrates essential equivalence of the machine learning process and outcomes.
- Prepare a user-friendly set of tools and rules to apply homomorphic encryption to the problem of machine learning and privacy preservation.
- Explore how the FHE will perform at scale with large datasets/changing of resources and demand on the system.

Topic 19
Developing techniques to enable analytic teams to make accurate judgments

Unclassified key words: reasoning, informal logic, rational discussion, expert disagreement, expert elicitation, human-computer interaction, argumentation, cognitive psychology, Artificial Intelligence.

Unclassified research topic description, including problem statement:
Humans solve many cognitive problems better when they talk with one another than when they work alone. A rich tradition in psychology has demonstrated that that the benefits of group work are far greater than most people think and that they cover a great range of problems, from classic reasoning problems to real-world tasks. Recent research has found that disagreeing parties who engage even in brief discussion often substantially increase the accuracy of their answers. Chen (2019) used a structured discussion method to increase the rate of correct answers from 67% to 98.8%. Schaerkermann (2018) found that discussion among disagreeing workers leads to substantially higher accuracy than non-discussion- based aggregation techniques.

Research is needed to develop effective techniques that would further improve discussions, particularly between people with initially differing answers to complex, real-world problems. The techniques would enable online or in-person groups of people to rapidly make accurate analytic judgments on a wide range of questions, including but not limited to forecasts. The techniques should be easy and natural for busy professionals to use on the job. They should require no formal training or knowledge of logic. The software interface should be self-explanatory.

People with doctorates in these disciplines are particularly encouraged to apply: philosophy, cognitive psychology, informal logic, reasoning, and computer science (particularly AI/ML and human-machine teaming).

Unclassified example approaches:
- Techniques that make it easier for participants to acknowledge that their initial answer was incorrect.
- Methods to help people discover the sources of their disagreements more rapidly.
- Human-machine teaming that enables people to articulate their reasoning more clearly.

Topic 20
Quantum engineering for quantum sensors

Unclassified key words: quantum, quantum engineering, quantum sensors, atomic sensors, machine learning, control theory, quantum control, signal processing, enabling technology for quantum sensors, magnetometer, gyroscope, accelerometer, gravimeter, atomic clock, atom interferometer, NV diamond.

Unclassified research topic description, including problem statement:
This topic is about using quantum engineering to make quantum sensors easier to build and operate, both in the laboratory and in the field. Quantum sensors are devices that encode a physical quantity into a few quantum states of the system- for example, atomic magnetometers, atom interferometer gravimeters, atomic clocks, NVD magnetometers, and so on.

Quantum sensors may optionally utilize non-classical states to increase their performance. As quantum sensors become more sensitive and accurate, a key remaining challenge is to make them more practical outside of the laboratory. They need to be easy to operate, fast to turn on, robust against vibration and thermal changes, small and low power. The emerging field of quantum engineering can address these problems by applying standard and new engineering techniques to quantum devices.

Unclassified example approaches:
Example approaches will depend on the maturity of the quantum sensor and its intended application environment. Some interesting directions include (but are not limited to) using machine learning techniques to simplify the user experience, using quantum and/or classical control techniques to increase robustness against noise, employing digital signal processing algorithms to increase sensor speed or improve accuracy, and applying advanced packaging techniques to reduce sensor size. These techniques may also be used to improve the performance of enabling technologies for the quantum sensor, such as lasers, photonic integrated circuits (PICs) or photon detectors, but the proposal should then include the use of these enabling technologies in an actual quantum sensor. Proposals may include work on theory, modelling, or algorithms, but must apply these to a quantum sensor in the lab during the first year of the effort.

Topic 21
Materials informatics for rapid and efficient design of new systems

Unclassified key words: materials modelling, materials informatics, materials design, rapid R&D, smart manufacturing, reverse engineering.

Unclassified research topic description, including problem statement:
The rapid advancement of materials modelling has given rise to a new field, often called materials informatics or materials genomics. Descended in part from the Materials Genome Initiative, this line of research focuses on connecting the underlying physical and chemical properties of materials to their macroscale properties (i.e., hardness, corrosion resistance, melting temperature).

This information, in turn, can be used to design new combinations of materials to more rapidly iterate through the R&D process and achieve key performance metrics. Oftentimes, materials informatics studies incorporate some elements of machine learning to assist in quickly screening candidate materials and selecting possible combinations. Other key features, like cost and availability, are often considered as well.

This research topic would seek to advance the science of materials informatics through development of improved models, machine learning algorithms, and collection/aggregation of basic materials data. Current models have difficulty capturing the complexity of multicomponent systems under a variety of environmental and operating conditions and are often made via empirical observations and interpolative analyses. This research effort would seek to close these knowledge gaps and work towards development of a more comprehensive system for faster material design.

Unclassified example approaches:
One direction could be to focus on developing an informatics approach to enhance R&D for a specific system- i.e., a database of materials for satellite design. An alternative could be to develop an informatics-based approach to reverse- engineering of systems (i.e., if a component does X, then it could only be material Y or Z). Further approaches can include investigation of materials science properties in an attempt to strengthen current models and expand their use to more complex systems.

Topic 22
Synthetic aperture RADAR automated exploitation

Unclassified key words: synthetic aperture RADAR, SAR, AI, machine learning, computer vision, maritime domain awareness.

Unclassified research topic description, including problem statement:
Maritime Domain Awareness (MDA) is important to security. A key issue to enabling MDA is the ability to detect and classify an object, particularly in open water, in all weather conditions and in a timely manner. While space-based commercial synthetic aperture radar (SAR) could meet most of these criteria there is a high learning curve for human analysis which can require substantial time to analyse a single image. The ability to automatically exploit SAR imagery would facilitate the development of person-on-the-loop (i.e. automated) rather than person-in-the-loop (i.e. manual) approaches to collection and analysis for MDA.

This topic aims to develop algorithms to run over space-based SAR satellite data and provide confidence levels for the classification of any given detection for MDA. The predominant inhibitor to person-on-the-loop approaches to collection, using commercial systems (e.g. tipping and cueing), is the inability to recognise vessels of interest from SAR imagery. The NIC is interested in a scenario where broad-based tracking systems, such as the maritime Automatic Identification System (AIS), provide an overall maritime domain awareness, and then use commercial SAR systems to undertake automated analysis of specific vessels, or monitor specific areas of interest for vessels that are not emitting an AIS signal.

Specifically, automatically exploit SAR imagery to:

- From SAR imagery, recognise to some level of confidence: o a military vessel (at sea) of length 50m or longer. o a fishing vessel (at sea) of length 10m or longer o a commercial shipping vessel (at sea) of length 50m or longer or a military, fishing or shipping vessel (in port or harbour) on SAR imagery.
- Understand at what SAR imagery resolution (or other parameters) detections of different sizes or classes of vessel can no longer be classified to certain levels of confidence.
- Understand the optimal collection geometry and conditions to improve the chance of classifying vessels on SAR imagery.
  - For example, sea state, grazing angle, imagery resolution (IPR), displacement and smearing effects, etc.
- Understand common groups of confusers (vessel classes that are easily confused for each other).
  - For example, vessel classes X, Y & Z are often confused for one another, but are easily distinguished from vessel classes A, B and C.

Desired outputs would include algorithms to perform SAR analysis, as well as an account of the current limitations of such algorithms (e.g. see point 2 above) and exploration of potential future methods to overcome these limitations. Other outputs of interest include the characterisation of vessels that are not transmitting an AIS signal, but are transmitting other signals (e.g., radio frequencies associated with phones, or UHF/VHF radio).

Unclassified example approaches:

It is expected that access to, or development of, labelled SAR datasets will prove challenging. Thus, the first part of any approach will likely involve developing labelled SAR datasets.

Labelled data might be developed using some combination of the following methods:

- Synthetic data (including simulated motion-smearing and other relevant SAR imagery effects)
- AIS correlated with SAR imagery
- Commercial Radio Frequency (RF) signals collection correlated with SAR imagery
- Electro-optical imagery correlated with SAR imagery.

A combination of these methods could be used, for example, focusing on a smaller correlated data set for validation and a larger synthetic data set for testing. A method to develop and implement a confidence rating for different data sources may be useful to mitigate limitations of individual data sets. An option for unlabelled imagery might be to use Sentinel or NovaSAR data, or other commercially available SAR imagery. NovaSAR also has the ability to co-collect SAR and AIS data which could potentially be used to produce a limited labelled dataset.

Following the development of appropriate datasets, multiple modelling approaches might be taken. These will likely be influenced by the size and quality of the available data, but might include:

- Conventional computer vision approaches
- Analysis of pre-image formation data (i.e., SAR phase history data, before it is processed into an image)
- Deterministic/rules-based approaches
- SAR cross section for classification
- Combined approaches using multiple methods to filter detections with increasing confidence levels.

Topic 23
Integrated multimodal facial recognition technologies

Unclassified key words: facial recognition, vision transformers (ViT), machine learning, video sense-making, real time analysis, video multimodal fusion.

Unclassified research topic description, including problem statement:
Facial recognition technology has been a longstanding challenge in the field of computer vision, with existing applications struggling to achieve accuracy in diverse real-world scenarios. Despite recent advances, there remains a need for further research to overcome the limitations of current methods and improve their robustness, particularly in situations where faces are partially occluded, poorly lit, or exhibit varying expressions.

This research topic investigates the use of new models, such as vision transformers, for facial recognition, with a focus on developing techniques to accurately evaluate the confidence of matches and interpret the embedding space. A key limitation of current systems is that they do not scale into downstream use cases as their inaccuracies compound, limiting their applicability. The research might also explore the combination of multiple modalities, such as audio and face recognition, and the incorporation of video data to enhance the accuracy of systems. Finally, the project would examine the potential applications of the developed techniques for other embedding searches, such as sentence embeddings.

Unclassified example approaches:
Proposals are likely to approach this Topic from an applied vision transformers (ViT) perspective. A literature review with respect to facial recognition and recently emerging associated fields could inform experimental work, e.g., AI/ML enhanced ViT, may be relevant.