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CAP 1777 ELECTRONIC CONSPICUITY SOLUTIONS A CALL FOR EVIDENCE ON A NEW STRATEGY - BRITISH GLIDING ASSOCIATION RESPONSE

Introduction and Key Points

Gliding has been the first general aviation (GA) sector to widely adopt, through individual voluntary equipage, a means of electronic conspicuity. Most soaring and training gliders now carry FLARM. We have followed technical developments with close attention, and participated in many discussions with the CAA, NATS, Eurocontrol and others on potential deployment of FLARM and other electronic conspicuity (EC) technologies.

The BGA would welcome an approach to further deployment based on voluntary adoption of EC technologies driven by the benefits they bring to pilots.

However, the main reasons CAA gives for proposing the **full adoption of EC solutions across all areas of UK airspac**e are….

- **Implied increase in CAT traffic in uncontrolled airspace**. No reason is given in CAP1777 or CAP1711 why this is expected, nor quantified forecast. With very few exceptions, airports with CAT traffic and serving the main population & economic activity areas can already access the en-route network without transiting uncontrolled airspace. There does not appear to be any reason to expect significant increase in CAT traffic to other airports, via uncontrolled airspace, either.

- **Increase in UAS traffic**. No explanation is given of the UAS operational modes which might result in conflict, nor quantification of the traffic levels at which, or when, this risk might become significant.

Our view is that, for the foreseeable future it is **not justifiable in any terms to embark on a program leading to mandatory deployment of EC in all airborne vehicles in all UK airspace**, which is apparently the intention of the AMS[1] and the subject of this consultation.

We do accept the principle that there may be justification, in specific circumstances and limited areas, for some airspaces to be accessible only to aircraft carrying one or more of a range of adopted means of EC.

[1] Mandatory EC for all aircraft in all UK airspace was introduced in The Airspace Modernisation Strategy (CAP 1711) even though it was not included in the preceding consultation documents and did not result from published feedback.

With regard to interoperability of EC solutions, which we also see as desirable, it must be acknowledged that the differing operating patterns of different classes of aviation have led to the development and deployment of different EC solutions for different types of conflict risk. Enabling interoperability between aviation classes must not degrade the benefits of what is in use today and should impose neither costs nor re-equipage obligations in one class for the reduction of risk in another. Of the two main forms of interoperation[2] a mediated system is least disruptive and has most scope for flexibility in future use.

An adopted interoperable electronic conspicuity environment must work for all classes of aviation with their diverse operating patterns, as articulated by the CAA's Electronic Conspicuity Working Group (ECWG) in 2014[3], which established a common minimum set of requirements from the GA perspective.

Currently, collision risk for each class of aviation is predominantly with other aircraft of the **same class**. E.g. GA-GA, CAT-CAT. The same is likely to be true of UAS, particularly Class I-IV[4] which operate predominantly in LFR[5]. The basis of the CAA proposed strategy for Electronic Conspicuity is essentially to tackle the collision risks between aircraft of **different classes.** These are second order risks.

Since the operational practices of each class (and to a very large extent where they fly) are different, the approach to collision avoidance is different for each, and the way to reduce collision risk will be different for each. The majority of aircraft are never exposed to the second order risks, so the introduction of a pervasive and mandatory EC solution is not justified.

Summary

This is a complex, interwoven issue, and the document conflates different objectives, constraints and timescales resulting in misleading associations between different consequences of implementation which are not linked and or are of quite different level of importance. In particular, the closed questions are each, in effect, several questions, and the answer to any is likely to be misunderstood as the answer to all!

CAP 1777 proposes a policy of progressive mandatory EC across all UK airspace that contrasts starkly with the CAA's previously stated principle of voluntary carriage based upon benefits to individual pilots and operators. It bases this policy upon a number of unsound premises listed below which are commented on in detail in the rest of this document:

a) speculative, unsubstantiated assertions about future UAS volumes and patterns
b) unrealistic assumptions about how soon integrated airspace use can be achieved
c) confusion between the commercial costs of airspace infringements and mid-air collision risk

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[2] Interoperation can be

1) **Direct.** i.e. interaction directly between the instruments in each aircraft, implying all using the same protocols or able to interpret multiple protocols simultaneously. This approach almost certainly implies a major aircraft re-equipage program.
2) **Mediated.** i.e. via an infrastructure which can receive multiple protocols, translate, and broadcast in multiple protocols. While this implies the deployment of an infrastructure (land, satellite, or airborne), it does not depend on replacement of existing aircraft equipment)

[3] ASI ECWG *Recommendations Paper: Electronic Conspicuity in Class G Airspace* (Aug 2014)

[4] UAS Integration Operational Concept (Eurocontrol November 2018)

[5] Below 500ft AGL

d) claimed advantages of EC that are rarely or never possible (avoidance of controlled flight into terrain; VFR flight without VMC)
e) potential “selling points” of EC that are unrelated other than by common packaging (‘value-add’ services such as weather, routing and airspace information) and are not significant in attempting to justify implementation;
f) failure to recognize that GA flight in uncontrolled airspace is not about the shortest straight route and the least time in the air.

Also, as described above and in more detail below, it
g) favours full interoperability which, without explicit definition, may be taken to involve significantly increasing the load upon the protected but already congested radiofrequency used by critical CAT safety systems, and
h) does not recognize that the needs of different aviation sectors may be largely satisfied by separate EC systems augmented by ground-based links in congested areas.

Indeed, the proposal fails from the start to identify and distinguish between the different aims, constraints and solutions that EC is intended to achieve.

1 Mandatory EC

A key principle throughout the existence of the CAA's Electronic Conspicuity Working Group (ECWG) has been that equipage should be voluntary, risk-based and proportionate, led by the benefits brought to the individual pilot. The proposed adoption, new in the Airspace Modernisation Strategy (December 2018), of a mandatory and pervasive approach to EC was unexpected. This has been carried through to CAP 1777 which envisages "the full adoption of interoperable EC solutions in targeted blocks of airspace" whereby "every airborne vehicle … can detect and be detected using interoperable EC solutions", with "full adoption of EC solutions across all areas of UK airspace to be the eventual conclusion of this targeted approach". The BGA does not support this approach, because

1. the additional burden of mandatory EC carriage will be carried by GA pilots, but many of the claimed benefits will be to other parties such as ANSPs, CAT and UAS operators
2. there is no prospect of many of these benefits being realised until fledgling ideas for future airspace and UAS operations have been developed, tested, agreed (sometimes internationally) and implemented
3. some of the benefits claimed of full adoption, such as UAT integration, route planning and widespread CAT use of Class G airspace, do not account for the practical eventualities of equipment or systems failure and are unlikely to prove acceptable solutions to CAT operators or passengers
4. while mandatory carriage of EC equipment may initially be restricted to targeted airspace, it will involve installation in any airframe that will ever use that airspace, and hence a large number of aircraft even if the targeted airspace is small: the concerns correctly expressed in para 97 extend to the situation of para 98, and the arguments in para 98 about reducing and apportioning costs are incorrect
5. the capacity of the 1090 MHz band to accommodate full adoption of ADSB by GA in congested airspace has not been demonstrated, and no alternative means of establishing interoperability with CAT EC systems has been considered

In particular circumstances where the impact of these concerns can be demonstrated to be low we could envisage the use of mandatory EC as a means of allowing access to hitherto restricted airspace. However, these would be individual, special cases rather than part of a UK airspace strategy, and would extend rather than constrain airspace access. It would not be acceptable for a two-step process, of introducing airspace restrictions and then partially removing them subject to EC carriage, to result in a net reduction in access.

- The BGA does not support the approach of mandatory electronic conspicuity as outlined in CAP 1777.
- The principles of EC policy, especially the approach to mandatory nationwide carriage (which has not hitherto been the subject of consultation and was newly introduced in AMS (December 2018)), should be dealt with through a focused formal consultation, not as part of a broad call for evidence.

2 Interoperability

CAP 1777 blurs a number of quite distinct objectives and their consequences, and arrives at the proposed solution without analysis of the different requirements. The risk patterns, levels and acceptability, technical performance in terms of precision, accuracy, update rate, range and data integrity, all depend upon the role addressed. For example

- The principal collision risk for **GA pilots** is other GA aircraft and occurs in close manoeuvring environments near airfields and in thermals, so the EC solution must provide precise, frequent, low-latency, short range data exchange. EC is a supplement to the existing mechanism of see-and-avoid, so high reliability, data assurance and spectrum protection are not required.
- In contrast, the principal collision risk for **commercial air traffic** (CAT) is other CAT when concentrated into specific levels or corridors: the high speed and low manoeuvrability require frequent, low-latency, long range exchange of low resolution, high integrity data; the risk is small but unacceptable and often results from failure of the principal separation mechanism of ATC and, together with the need to avoid violent manoeuvring unless fully necessary, requires high reliability, a protected radiofrequency and active range confirmation in what is considered a critical safety system.
- The probability of **collision between CAT and GA** traffic in uncontrolled airspace is extremely low, having occurred only a few times in the history of aviation worldwide. The relative speed and manoeuvrability require occasional, low resolution, modest latency, long range data exchange to supplement the primary mechanism of see-and-avoid and the ‘big sky’ principle. In controlled airspace, the risk profile is similar but the data rate and resolution may need to be higher, and the latency and range lower.

The requirements are again different for interactions with military aircraft and unmanned aircraft (UASs). It is apparent that different collision risks set different performance requirements. An EC system that is inappropriate for a given role may not only be less effective, but may also be more distracting if, for example, it gives false warnings due to poor data or inappropriate warning thresholds. No current EC system offers the range and integrity required by CAT and the precision needed by close manoeuvring GA.

Interoperability is not defined in this document, but there are in principle two approaches:

1) Direct. i.e. involving direct air-to-air links, in which (para 81) “information from airborne devices must be transmitted with sufficient power, continuity and integrity” for air traffic services (ATS), unmanned traffic management (UTM) and CAT users;
2) Mediated. i.e. received and rebroadcast (with necessary protocol and or spectrum translations) by ground-, satellite, or airborne infrastructure systems (para 86).

Direct interoperability commonly leads the adoption of the highest performance standards regardless of the operational role, resulting in unnecessary equipment and maintenance cost and procedures, increased apparatus bulk and power/antenna requirements. It also places the full burden upon the chosen system, making what is for some a critical system vulnerable to overload by those for whom it is a non-critical enhancement.

For this reason, the US has adopted separate systems for CAT (ADS-B) and GA (UAT), with ground mediation infrastructure to link the two in congested areas. The ground infrastructure could in principle carry out data validation (eg by multilateration or data fusion with primary or secondary radar) to allow critical systems to take advantage of lower integrity data originating from non-critical systems commonly used in some aircraft classes.

The risk of mid-air collision is mostly either between GA aircraft or between CAT. There is little need for direct interoperability of EC systems between these two sectors and, while a single fully interoperable EC solution is aesthetically pleasing, the risk that it mitigates may be extremely low.

- The BGA supports interoperability via a mediated system, which would enable transmission of position data between different classes of aviation without the need for replacement of existing, or class-specific conspicuity systems.
- The BGA does not support a strategy of direct interoperability with existing 1090 MHz systems as this is likely to require unnecessary levels of equipment performance, maintenance and certification for the principal GA requirements, while also overloading the critical safety systems for which this protected radiofrequency is currently reserved.

3 System diversity and translation

Several different EC systems have already been developed to address the primary needs of different aviation sectors. A high degree of interoperability has been achieved at national level by combining additional receivers within airborne apparatus and ground-based relay infrastructure[6]. The need for direct EC interoperability between different aviation sectors is slight; receiver duplication is cheap; the radiofrequency spectrum is precious and heavily loaded. In its own discussions, EASA has actively involved representatives from FLARM and PilotAware. Unless 1090 MHz EC standards are to be redefined globally to match 21st century requirements and technology, the CAA should explore the potential offered by existing systems together with ground-based translation, validation and rebroadcast, and establish the real-world performance of these systems in presenting timely traffic information.

- The CAA should explore the potential of a pluralist approach that embraces existing EC solutions and links them via ground relay.

4 Airspace

Airspace worldwide is currently divided into different classes to segregate CAT from GA or allow dynamic separation via air traffic control (ATC). In the future, this system may be partially or wholly replaced by one in which all aircraft are separated by EC-based technology. However, the future integrated system is still on the drawing board, with major technical, organizational and administrative hurdles to be overcome, and agreed internationally, before any prospect of fruition. It would be premature to allow the distant and uncertain future to shape the current strategy for GA EC.

- The current EC strategy should not be based upon potential benefits that depend upon the future introduction of integrated airspace.

5 Air Traffic Service infringement monitoring

A major part of the case for EC refers to infringements of controlled airspace, which are said to carry risks of mid-air collision, disruption and delay to commercial operations and increased ATC workload.

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[6] Websites https://pilotaware.com/ogn/; https://flarm.com/flarm-and-uavionix/; https://pilotaware.com/modes3d/; https://flarm.com/products/powerflarm/powerflarm-core/

The risk of mid-air collision resulting from an airspace infringement, while of grave consequence, is miniscule: there has been to our knowledge only one case worldwide in the history of aviation. Our analysis of 18 months' infringements of the Southampton CTR and Solent CTA[7] shows that most infringements were minor, quickly corrected and of no consequence, and in many cases were caused by poor airspace design or ATC errors and miscommunications. The UK criteria for CAT separation do not distinguish between ahead of, to the side of, or behind the aircraft or their individual or relative airspeeds. As a result, often when a 'loss of separation' is deemed to occur a collision is physically impossible.

Infringements are rare, and any claims of disruption and delay to commercial operations should be supported by quantitative evidence.

The combination of simple historical separation criteria and ATS operational regulations may indeed mean that airspace infringements result in increased workload for air traffic control, but these commercial considerations should not be a predominant factor in EC policy or airspace design.

Similarly (para 81), it should not fall solely to the airborne devices to ensure sufficient power, continuity and integrity for ATS and UTM providers: the ground receiver network should have sufficient coverage, sensitivity and data validation for these purposes.

- While airspace infringements can lead to disruption, delay and commercial penalties, the associated risk of mid-air collision is insufficient to justify extending EC to all GA aircraft.
- Commercial considerations, especially when resulting from arbitrary separation criteria and operational processes, should not be a basis for airspace design.

6 Air Traffic Service situational awareness and service provision

Much of the case for EC is based upon the provision of air traffic services outside controlled airspace (ATSOCAS) or around small airfields. In such cases, the air-to-ground role of EC is to enhance the awareness by the ATS provider of the airborne situation. The risk patterns, levels and acceptability, and technical performance requirements again differ from those in air-to-air roles. EC can supplement situational awareness that is currently based upon pilots' position reports, which are notoriously unreliable, and Mode C barometric altimeters, whose failure is thought sufficiently likely to merit specific radiotelephony phraseology[8]. High reliability, data assurance and spectrum protection are not required for EC to provide a significant enhancement; EC carriage need not be obligatory, and the ease of fusing data streams in ground equipment means that there is no need to constrain EC reception to a single system. The UK Airprox Board recently recommended[9] that the CAA and MAA should "review the regulations and procedures pertaining to ATC use of 'unassured data' such as FLARM for the provision of Traffic Information."

It must be recognized that ground-based reception of EC transmissions is greatly constrained by geography, and that, away from airfield bases, coverage at typical GA altitudes is likely to be poor. The effectiveness of ATS-mediated situational awareness hence depends upon an extensive national network being established.

The document claims that EC systems can in uncontrolled airspace help avoid controlled flight into terrain. This depends upon ATS monitoring aircraft altitudes and warning of terrain. ATS outside controlled airspace does not provide this function within a Basic service, and to

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[7] BGA, *Infringements of Southampton CTR and/or Solent CTA* (Sept 2016)
[8] CAA, Radiotelephony manual, CAP 413, 21st edition (Nov 2015)
[9] UK Airprox Board report 2018266 (March 2019)

pilots in receipt of a Traffic or Deconfliction service only by notifying pilots when they descend below the ATC unit's terrain safe level[10] and, as part of a Deconfliction service only, on approach and departure. GA traffic may often fly below the ATC unit's terrains safe level, and ATS coverage at such levels may be limited by geography. The provision of Traffic and Deconfliction services will often be limited by ATS capacity.

The document also suggests that EC could help mitigate unexpected degradations in visibility – a situation in which the noted potential for distraction could be most serious, and which appears to condone visual flight rules (VFR) flight outside visual meteorological conditions (VMC).

Finally, it should be recognized that Class G airspace is uncontrolled: the pilot is responsible for collision avoidance, and contact with ATS is only an optional supplement. The wider introduction of EC should not result in a deliberate or de facto change in the nature of Class G airspace.

- The BGA supports the use of ground-based EC reception to supplement and enhance situational awareness for or mediated by ATS outside CAS and near small airfields.
- This role as a supplement to existing situational awareness does not merit high reliability, data assurance and spectrum protection.
- The ease of data fusion in ground apparatus means that EC need not be confined to a single system.
- All current EC systems (ADS-B, FLARM, PilotAware) should be satisfactory for this role.
- The likely benefits of EC do not include avoiding controlled flight into terrain or VFR flight below VMC.
- The nature of flight in Class G airspace should be appreciated and retained.

7 Airspace targeting

We support the principle (para 100) that airspace design should be based upon data and intelligence, that EC deployment (para 17) will be more suitable for some areas of airspace than for others, and (para 15) that EC policy should be evidence-led. However, the existence of an evidence-based rationale should not allow the consultation aspects of the airspace change proposal (ACP) process to be bypassed.

- While the BGA supports the requirement for rational, data-based arguments, airspace changes should nonetheless be subject to the consultation and scrutiny of the ACP process.

8 Altitude encoding

CAP 1777 refers several times to the provision of barometric rather than GNSS-derived altitude information. Whereas GNSS is essentially self-calibrating, and indeed usually provides properly calculated estimates of the data uncertainty, drift or scale factor, changes in barometric sensors are only apparent when compared with a separate source. The need for an additional sensor and, more significantly, calibration and assurance mechanisms and processes, add unnecessarily to the cost of a system that is intrinsically less reliable. We note that the ADS-B specification allows for either barometric or GNSS-derived altitude

[10] CAA, *UK Flight Information Services*, CAP 774 (Feb 2015)

data[11], that GNSS-derived altitudes are considered better able to provide the higher accuracy needed for GA purposes[12], and that locally systematic propagation errors do not affect collision alerting/avoidance. Any situational awareness or collision avoidance/alerting system that is not based exclusively upon transponders will have a GNSS position source that will provide altitude information.

- The EC altitude should be derived from GNSS, not barometric measurement.

9 'Value-add' services

The document outlines the potential for provision of weather, routing and airspace information as an additional function of the EC system. There is no intrinsic overlap of this functionality with that of electronic conspicuity and, while the two functions could indeed be combined in single device, there is no reason why a simple receiver could not be marketed to decode this information which is likely to be broadcast using a different frequency and coding than any currently certified EC system. An EC system could be integrated with many other equally unrelated functions; they are not features of the EC system itself.

- Unrelated 'value-add' services should not be construed as benefits of an EC system with which they are packaged.

10 Geographical constraints and EASA certification

Many GA aircraft fly overseas; most are administered within the EASA system. It is crucial that the installation and carriage of any EC system be legal in EASA-registered aircraft and for flight across the European continent. An incompatible, UK-only requirement would cause difficulties for UK aircraft travelling overseas and overseas aircraft visiting the UK. Permanent installation of EC apparatus that does not comply with international (RTCA/EuroCAE) standards is not permitted in EASA-regulated aircraft.

- Any adopted EC solution must be permitted for permanent installation into EASA-regulated aircraft.
- The installation of the adopted EC solution must not prevent overseas operation of UK-based aircraft into which it is fitted.
- Any UK solution should permit overseas aircraft to continue to visit the UK.

11 Flight efficiency, cost effectiveness and efficient use of airspace

The document mentions routing efficiency and flight path optimization, but fails to note that most GA pilots fly for pleasure: minimizing their time in the air is rarely a consideration, whereas they value the freedom to fly where, when and in whatever manner they choose.

Some of the stated benefits of EC, such as the use of EC data by CAT to plan (pre-flight) and re-plan (during flight) more efficient flight paths (paras 25, 31) assumes that GA traffic will be predictable, whereas it will instead change rapidly according to weather and whim.

[11] RTCA, *Minimum Aviation System Performance Standards for Automatic Dependent Surveillance Broadcast (ADS-B),* DO-242B (2002)

[12] Website https://support.flarm.com/hc/en-us/articles/115002659433-What-is-the-pressure-sensor-used-for-

- Measures for the impact of EC upon aspects unrelated to flight safety should include the freedom of GA pilots to fly where, when and however they choose.
- Claims for CAT efficiency enhancements should take account of the unpredictability of GA traffic.

12 Unmanned Aerial Systems (UAS)

The document places much emphasis (eg paras 3, 6, 14) upon the integration of manned and unmanned aircraft, especially when UAS are operating beyond visual line of sight (BVLOS). It asserts significant forecast growth and expectations that this will generate significant economic value. Neither of these claims is quantified or substantiated; nor are the operating patterns – in particular, heights – considered beyond (para 49) requiring limited access above 5,000 ft. It seems likely that most UAS movements will be at low level and often concentrated in populated areas where GA will be absent through good practice and the adherence to the *Standardized European Rules of the Air*[13].

The obligations, mechanisms and expectations regarding the avoidance of collisions with UAS are a major topic that, until the technology and UAS market have developed further, has yet to be resolved. The document acknowledges this in its statement (para 26) that “the full and permanent known environment created by … EC information is a foundation from which to develop and deploy solutions for airspace integration and for UAS operators to fly BLVOS in uncontrolled airspace.” It is premature to use UAS integration as a basis for EC policy.

CAP 1777 makes contradictory statements: paras 14 and 65 place expectations on UAS operators to “detect and avoid other airspace users” and make integration contingent upon the transmission of EC information by all other nearby airspace users; paras 26 and 32 however state that UAS movements in uncontrolled airspace may at times “reduce the volume of available capacity for conventional manned airspace users”, and that UAS integration might depend upon the reception of electronic surveillance information by other airspace users. The principles of UAS integration appear to be completely undetermined.

- UK airspace should not be designed around unquantified, unsubstantiated estimates of UAS traffic volumes and flight characteristics in a market that has yet to develop.
- The principles and operational methods of UAS integration are major questions that need to be developed separately before EC policy is based upon them.

[13] CAA, *SERA Air Navigation Order and Rules of the Air Regulations 2015 – consolidation* (April 2019)

CALL FOR EVIDENCE QUESTIONS

1 Should the CAA act to coordinate the adoption of interoperable EC solutions in targeted blocks of airspace?

☐ Yes ☒ **No** ☐ Don't know

Reason: *This conflates (a) the adoption of EC, (b) interoperability, and (c) the CAA's role in coordination. If adoption is to occur, there is a role for the CAA in coordinating it, but 'yes' could be interpreted as supporting adoption. The question does not address who will identify the targeted blocks, with what criteria, or through what process. The document does not define, and is inconsistent in referring to, interoperability: ground-based connection between different systems could be a better solution than universally adopting ADS-B.*

2 Do you agree with our strategy to coordinate the full adoption of interoperable EC solutions in targeted blocks by using location specific mandates?

☐ Yes ☒ **No** ☐ Don't know

Reason: *This seems to be nearly the same as question 1, but for the addition of 'full' adoption and 'location specific mandates'. The question omits, but the document makes clear, that the targeted blocks are only the first steps in the CAA strategy of EC mandate covering all UK airspace. We do not support this strategy.*

3 What EC functions should the CAA focus on when coordinating adoption?

1) ☐ transmit only,
2) ☐ transmit and receive,
3) ☐ transmit, receive and rebroadcast, or
4) ☐ a combination depending on the need.

Reason: *This seems to muddle airborne and ground infrastructure and assumes positive answers to questions 1 and 2. Any EC system requires some transmitters and some receivers, but not all aircraft require both functions, and a ground-based rebroadcast system may be an appropriate element. The LARS limitations of para 22 could be ameliorated by a receive-only function, but not by transmit-only. The CAA should not focus upon transmit, receive or rebroadcast functions in the abstract.*

4 What evidence should be used? This question considers whether the best available evidence is being used and if there is anything that could be done to improve the data available to decision makers.

Response: *The CAA should gather and present*

(a) data on the number and circumstances of airspace infringements that have (i) any possibility and (ii) a real risk of mid-air collision;
(b) analysis into the reasons for those infringements;
(c) data on the current use of 1090 MHz, its projected use were the proposals to be adopted, and the effect such use would have upon the performance of critical systems such as TCAS, compared with internationally specified minima
(d) the average and peak densities of GA traffic across the country, with particular emphasis upon bottlenecks and areas known to be busy, and the implications for collision risk in Class G airspace;
(e) the effect of EC upon situational awareness, complacency and distraction;
(f) data on the delays and controller workload resulting from airspace infringements;
(g) the comparative risks of GA-GA, GA-MIL, GA-UAS, GA-CAT, MIL-CAT, GAT-UAS, MIL-UAS and CAT-CAT collisions and the situations in which they occur;
(h) the empirical reliability of data from Mode-A/C/S transponders, certified GPS, consumer GPS, FLARM, PilotAware, pilot position reports, controllers' binoculars;

(i) *the robustness of 1090 MHz systems, FLARM and PilotAware to jamming, spoofing and interference.*

5 **Have all the options been considered? This question considers whether there are other approaches that could also be considered.**
Response: *The CAA approach is excessively based upon a single universal solution. Had it analysed the problems it wishes to solve, it would have found that they are largely confined to individual sectors, allowing separate solutions that can be connected by ground-based links to mitigate the limited problems that remain.*

6 **Do you have any specific feedback on the suggested approach? This question aims to gather feedback from stakeholders on the scenarios presented in Part 2, the technical functions for EC solutions outlined in Part 3 and our suggested approach to coordinating deployment proposed in Part 4.**
Response: *(Given in pp1-9 of this document.)*

Pete Stratten
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