COTS to Capability: Lessons learnt from UK MOD research programme

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ABSTRACT

The future of training involves simulation, which is often delivered by Commercial Off-The-Shelf (COTS) products. This principle was embraced by the United Kingdom (UK) Ministry of Defence (MOD) in 2010, under its Strategic Defence and Security Review (SDSR), and heralded the beginning of a paradigm shift in the way the MOD customer viewed simulation and COTS solutions. Given budgetary constraints and the need for a flexible, adaptive training capability in support of future military operations, the commitment to embrace COTS is a bold and sound step. However, whilst COTS offers obvious advantages, there is a perception that COTS provides the entire answer, and that procuring a training capability is as simple as walking into a store, picking a training solution from the shelf, taking it home and plugging it in.

Unfortunately, although this approach can work for commodity items, it's not always suitable as the basis for developing mission-critical training capability. In particular, the technical specification or level of innovation in an COTS product are not the only things that customers should consider when contemplating their options. They need to ask if they have considered the implications for meeting the training objectives, technical integration, safety, business or procurement or commercial processes, and legislative compliance. Does the training task really need a 6 Degree of Freedom motion platform? Does a foreign product meet your country's safety legislation? Can the product be easily integrated with existing solutions?

Asking the right questions early can save time and money and avoid disappointment. This paper reports the lessons-learnt during a series of training-related Technology Demonstrators undertaken under a MOD-funded research programme investigating COTS. The lessons are presented in a simple check-list to help providers and customers manage and mitigate risks early in planning and delivery phases, helping to maximize the benefits gained from exploiting COTS.

ABOUT THE AUTHORS

John Kent John Kent has spent 25 years in the defense industry with a strong focus on training and simulation. He has helped the UK MOD develop enterprise architectures across training systems to facilitate training transformation, has considered innovative mechanisms for provision of training capability and has helped identify lessons from the recent use by MOD of disruptive COTS technologies to deliver training solutions. John's original background is in multi-national software research programmes.

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Amy Stafford is a project manager with a background in operational analysis and analytical, statistical modelling. She has a broad range of experience in delivering operational analysis and floorplate consultancy support to MOD customers. She has good training and simulation domain knowledge having spent 7 years delivering and project managing T&S projects. Amy was responsible for managing the MOD COTS focused research programme under which the lessons identified in this paper were recorded.

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INTRODUCTION

Overview of the problem

The future of training involves simulation, which is often delivered by Commercial Off-The-Shelf (COTS) products. This principle was embraced by the United Kingdom (UK) Ministry of Defence (MOD) in 2010, under its Strategic Defence and Security Review (SDSR), and heralded the beginning of a paradigm shift in the way the MOD viewed simulation and COTS solutions.

COTS-based approaches allow defense users to benefit from commercial investment in new simulation technology, for example in the use of systems and technologies derived from serious games to support training. Such approaches can seem very attractive given the current downwards pressures on defense budgets. The rapid technological improvements driven by industry can also help defense users to maintain flexible and comprehensive training capability in support of future military operations in a rapidly changing world.

However, there is sometimes a perception that COTS provides the entire answer, and that procuring a training capability is as simple as walking into a store, picking a training solution from the shelf, taking it back to base and plugging it in. This simplistic view can lead to disappointment and disillusion as the low cost of initial acquisition is offset by integration effort and through-live support, or when programmes are forced to conduct expensive multi-site upgrades to ensure they are using a currently supported version of a given product. Challenges can also arise in research and prototyping activities that are not subject to the checks and balances of formal procurement programmes. Clearly, asking the right questions sufficiently early can save time and money and avoid disappointment.

This paper therefore reports the lessons learnt during a series of training-related Technology Demonstrator Programmes (TDPs) undertaken during a MOD-funded research programme investigating COTS. The lessons are summarized in a simple check-list to help customers and COTS vendors to manage and mitigate risks in programme delivery. The intent of this paper isn't to provide a single definitive recommendation on whether or not COTS approaches should be used, but instead to allow potential users in different communities to perform more comprehensive assessment of COTS taking their own context and potential applications into account. The paper should help such users to maximize the benefits gained from exploiting COTS, and help ensure that innovation is not derailed by avoidable technical, commercial and legislative problems.

Definitions and conventions

For the purposes of this paper, the term 'COTS' is used to describe any item that is customarily used for non-governmental purposes and that has been sold, leased or licensed to the general public by its developer (Clapp J.A., and Taub A.E., 1988). Clearly, this definition covers a massive range of technologies ranging from simple network cables to state-of-the-art motion platforms. This paper therefore focused on specialist rather than commodity COTS products.

Many of the issues discussed in this paper apply equally to Government Off The Shelf (GOTS) and Military Off The Shelf (MOTS) systems. In this context, the unifying characteristic feature of COTS, GOTS and MOTS is that they are externally developed black-boxes whose functionality and future development cannot easily be directly controlled by a single end customer (not even a national defense acquisition organization). This is true even when specific products include customization features, such as a COTS simulation that includes a scripting language for defining nation-specific tactical behaviors. For the purposes of this work, such customization is not considered to be development of the underlying product itself.

A COTS CASE STUDY

Overview of the case study

As stated, this paper reports the lessons learnt during a series of training-related Technology Demonstrator Programmes (TDPs) undertaken by MOD research programmes. Specifically, it summarizes lessons from two projects that developed prototype training capability based on COTS products and one that used a COTS product in a test and evaluation (T&E) role. The training prototype projects were seen as successful in de-risking the use of the proposed technologies and as a result, the MOD went on to commission development of an operational training capability – the Close Range Weapons Trainer (CRWT) – which is now in service in the UK.

To help discuss the relevant issues in an open forum, the authors of this paper have developed a case study in which the actual participants and products have been replaced with fictitious equivalents. These are as follows:

- MOND – the Ministry of National Defence, located in a European Union (EU) country allied to the US.
- Offshore Boat Force (OBF) – a force within MOND that conducts small-boat counter-terrorism operations in the littoral environment. The boats used are fast, crewed by a commander and a gunner and carry a small number of marines. Training is conducted using real boats. This is highly realistic but requires additional training boats and is constrained by limits on live-firing in the training area near the main OBF base.
- QCorp – an organization that provides training solutions to MOND. Although it has an internal engineering capability, it uses and integrates third party COTS solutions where these offer the best value for money.
- Platforms-R-Us – a vendor supplying a range of motion platforms.
- Weapons-R-Us – a vendor supplying laser-based weapon emulations.
- Sims-R-Us – a vendor supplying military-quality simulations based on a serious games engine (MilSim3). MOND has already brought multiple licenses for MilSim3 for use in military training.

In this case study, OBF officers have recently visited a large international simulation conference and have seen separate products produced by Platforms-R-Us, Weapons-R-Us and Sims-R-Us. They would now like to develop a simulator based on these or similar products to support their training. MOND agrees in principle but first wants to conduct a feasibility study to determine whether COTS products will effectively meet the requirements. QCorps is therefore to integrate the various products to create a prototype that can be installed at an OBF base where user-evaluation can be conducted.

The following sections outline different phases of the solution development process and present summary analysis of the issues raised.

Requirements definition

Case study. QCorp engineers and OBF users meet to discuss the OBF requirement. The OBF describe their desired solution: a mockup boat hull mounted on a 6 Degree Of Freedom (DOF) motion platform with an emulated Machine Gun (MG) replacing the real weapon. The boat's controls are to be connected to a copy of MilSim3, which will in turn command the motion platform. A Weapons-R-Us machine gun emulation will also be mounted on the motion platform, allowing the gunner to fire at virtual targets generated by MilSim3.

QCorp engineers check the specifications of the COTS products and find that the preferred 6-DOF motion platform imposes a weight limit such that it can't support the proposed hull mockup. However, Platforms-R-Us also sell a simpler 3-DOF motion platform that can support larger weights. OBF staff confirm that this is acceptable – because the training task primarily involves the gunner and the boat commander synchronizing firing and steering, the motion platform only needs to represent roll and pitch rotation.

The QCorps engineers find that MilSim3 already includes a virtual model of a small attack boat (used by the US Marine Corps) which is similar but not identical to the OBF boat. OBF users agree that this US model would be acceptable for the purposes of the feasibility study. QCorps engineers proceed with the development of the prototype, but agree with MOND that because of the functional differences, the prototype should not be used to support Operational Analysis (OA) of OBF concepts during formal T&E.

Lesson: requirements flexibility. The hypothetical project was able to proceed because the users were able to flex their requirements (with respect to the type of the motion platform) to suit the actual capabilities of the COTS product. This can be beneficial in similar cases but creates a risk that user requirements might be shaped to reflect 'the art of the possible', not the real user training need. Note that situations where requirements are clarified during the course of a project can be relatively common during agile research programmes, whose purpose is sometimes focused on requirements elicitation prior to a more formal procurement of operational capability. However, this does not absolve such research programmes from the need to confirm emerging requirements with users before proceeding with implementation and acceptance activities.

Lesson: requirements fidelity. The users did not have precise requirements statements covering the desired simulation fidelity of the overall solution. This may not be a problem when both users and suppliers have a consistent understanding of the capabilities of available COTS solution technologies. However, there is a risk that poorly defined or vague fidelity requirements could derail user acceptance of a given COTS solution or lead to a solution that is less credible to trainees because some subtle but nevertheless important factor has been neglected. This is particularly important when a COTS simulation is intended to be used to generate hard data that will support quantitative decision making.

Lesson: product flexibility. The OBF users had stated an explicit requirement to use a specific product (MilSim3) so that they could build on prior experience with the use of that product. However, in general, limiting solution options in this way creates the specter of supply without competition and removes opportunities for engineers to exploit potentially superior solutions that were not known to the users. Ideally, requirements should be stated in solution-agnostic terms and should reference underlying standards and interfaces where technical compliance is required (MOD, 2011). Conversely, when users do mandate particular COTS products, they should accept that they will have less freedom than for a bespoke development, for example not being able to negotiate about aspects of the solution (e.g., simulation fidelity) that are constrained by the selected product.

Technical issues arising from integration and modification of COTS products

Case study. QCorps are integrating MilSim3 with the motion platform. Both products have compatible standards - compliant interfaces and have relatively high Technology Readiness Levels (TRLs)[1] so technical integration proceeds smoothly. During integration, a QCorps engineer manages to capsize a virtual boat during early testing of the simulation. Clearly, a capsize would terminate the training mission being conducted by the trainees, and its causes might be examined during After Action Review (AAR). However, the engineer wonders what would have happened if the simulation had been commanding the motion platform when the virtual boat capsized – the simulation designers had obviously assumed that virtual events would not have potentially dangerous real world consequences. Although the motion platform has hardware and motion limiters that should prevent unsafe commands from causing unsafe movements, the engineers request (and are granted) additional testing time to confirm that these limiters will function as required.

During the final stages of integration, QCorps engineers come across a newly-released alternative simulation model produced by a rival to Sims-R-U that offers a better representation of the OBF boat. They elect to stick with the existing MilSim3 product to avoid new integration and testing tasks, but note that the rival product should be potentially be evaluated should the prototyping lead to the commissioning of a formal training capability.

Lesson: Product integration. Adopting proven COTS products significantly reduces the technical risk to a TDP, given that such products will to some extent have been de-risked by use elsewhere and do not therefore represent unknown technologies. However, significant integration challenges can arise when multiple COTS products must be integrated together. Even though the individual components may have high TRLs, the overall System Readiness

[1] http://en.wikipedia.org/wiki/Technology_readiness_level

Levels (SRL) can be significantly lower when they are integrated for the first time. Resolving these integration problems can create a need for design, integration and test activities similar to those of a traditional bespoke engineering project in which components can be designed with 'whole-system' end-to-end functionality in mind.

Lesson: Product selection. The COTS market can change very rapidly over time as existing products are improved or competing products emerge. A product that is currently 'best of breed' can quickly be overtaken in terms of functionality and affordability by emerging products. This should be considered in longer running projects to avoid becoming locked in to obsolete technology or product versions.

Safety assessment

Case study. QCorps engineers visit the OBF facility where the trainer is to be installed. As expected, it has a suitably robust concrete floor to which the motion platform can be attached. However, the designated area has relatively high pedestrian traffic and this is assessed as creating a safety risk (passers-by might be struck by the motion platform). The OBF had been intending to use warning notices to prevent such problems but QCorps recommend that OBF should install an internal fence whose access door is interlocked with the motion platform (so that the platform will come to a safe halt if the access door is opened). They also recommend that the interlock should be connected to the building's fire alarm system so that the platform will safely halt in a building-wide emergency.

Lesson: Whole-system safety. Considerable care must be taken when COTS products are placed into an overall system that can present safety hazards to users, and the costs of mitigating safety risks must be taken into account when assessing project costs. The level of COTS-related safety risk will depend on the nature of a project and, importantly, may change as a given project progresses. For example, a one-day demo of a COTS-based system may be assessed as low risk because the product will only be used by skilled contractor staff in a carefully controlled environment. However, if the same system was left behind with users (as part of an unattended trial period), then a higher level of risk might be incurred, as (relatively) unskilled users might not be aware of equipment-specific safety issues.

Legislative compliance

Case study. As part of a corporate due-diligence process, QCorps staff consider potential compliance issues associated with the proposed solution. They find that the motion platform has not been used outside the US before and does not have a Conformité Européene (CE) Mark[2] to show that it conforms to relevant EU directives. It cannot therefore be legally used by MOND. There are two broad solutions – obtain a CE Mark for the motion platform or search for another product that satisfies EU legislation. In the event, QCorps opts to work with Platforms-R-Us to obtain a CE Mark. The process turns out to be relatively straightforward (there are specialist companies that support the accreditation process) but does create an additional unexpected delay. Luckily, because the issue was identified early, the overall schedule is not impacted. Platforms-R-Us cooperate enthusiastically because the process removes a barrier to use of this product within EU countries.

Lesson: Legislative compliance. A product developed in one country may be prohibited in another that has different (not necessarily more stringent) directives or standards. The COTS selection and evaluation process must ensure that products satisfy appropriate legislation, particularly when the product is manufactured outside the country where it will be used. (and may satisfy overseas legislation) or has not been previously sold within the EU.

Lesson: Compliance evidence. To avoid schedule slips, vendors should be questioned about the legislative compliance of their products as early as possible in the evaluation process. Ideally, a full set of compliance questions should be determined at the outset of the project and submitted to the vendor in a single batch. Similarly, there is a need to identify latest possible 'go/no-go' decision points and build these into plans and design reviews, even to the extent of terminating the work if no suitable COTS product can be found. This is especially true when products are subject to foreign export controls or US International Traffic in Arms Regulations (ITAR), adherence to which can create significant additional procedural hurdles to non-US countries (e.g., in terms of handling information and / or components covered by ITAR) and lead to heavy penalties for violations.

[2] http://www.ce-marking.org/what-product.html

Commercial issues

Case study. During the compliance check, QCorps discover that the US-sourced gas compressor (itself a COTS product) used by Weapons-R-Us to make the weapon emulation vibrate realistically is not labelled in accordance with EU legislation relating to vibration in the workplace. However, QCorps identifies a locally made compressor that has EU-consistent labelling and that is functionally identical to the US compressor. Following discussion with Weapons-R-Us this local equivalent is substituted by QCorps for the originally suggested compressor.

Lesson: Contractual agility. If a COTS-based project is initiated before the products themselves have been fully evaluated and down-selected, it is possible that development work may identify problems that can only be resolved by substituting one COTS product for another. This may require considerable commercial and contractual agility on the part of the customer, integrator and vendor if the project is to meet its original goals to time and budget. This can be particularly important when specialist COTS vendors (in this case Weapons-R-Us) themselves use commodity COTS products (in this case the compressor) as components in their own product.

Lesson: Creating a supply chain. The fact that a product is available 'off the shelf' does not necessarily mean that it can be accessed immediately on demand. Setting up the appropriate supply chain may require considerable commercial negotiation between integrators and vendors, even if this is not directly visible to the overall contracting authority. Project cost estimates based on raw COTS price alone are also likely to understate true costs, for example if they omit or underestimate additional commercial or technical activities. IPR and licensing dependencies must also be checked across the entire supply chain.

Through-life costs

Case study. QCorps engineers consider the on-site support required by the prototype whilst being used by the OBF. The user manuals supplied by the separate product vendors are assessed to be good enough to support day-to-day maintenance and usage although QCorps at the request of OBF write an integrated 'quick start' guide to cover start-up and shut-down activities that have to be performed in a particular sequence. Because the prototype will not support training activities, there is no need for service-level agreements covering utilization and availability or critical inventory holdings of spare parts. However, QCorps establish an office-hours hotline that can be accessed should OBF experience technical problems, and brief selected OBF staff on first-line maintenance tasks. OBF staff ensure that their budget includes consumables associated with the prototype (e.g., lubricants for the motion platform). Crucially, QCorps have arranged to lease rather than buy the motion platform from Platforms-R-Us. Although the lease period constrains the length of the prototyping exercise, it means that QCorps and OBF are not left holding expensive kit at the end of the exercise, and are not liable for disposal costs under EU rules relating to the disposal of electronic equipment (since the lessor recovers the asset at the end of the lease).

Lesson: Through-life cost estimation. The apparent savings (initial low cost of ownership) that result from use of COTS may be outweighed by integration, upgrades, servicing, spares, support, disposal and other through-life costs (MOD, 2011). Clearly, the magnitude of any such costs depends on the specific product and project but they should not be overlooked during project planning and assessment.

Lesson: Product lifecycles. In addition to unanticipated through-life costs, use of COTS products may also drive (or constrain) the technical phasing of a project, for example when technology refresh activities must be aligned with a COTS product upgrade path (if such a plan can in fact be provided by the vendor). The issue of technology refresh obviously applies to bespoke developments as well but for a COTS project, the refresh points will be less controllable by MOD.

Lesson: Service-level agreements. Projects need to consider service-level support agreements and warranty to cover both long term trial periods and specific planned training events.

Security

Case study. QCorps develop a set of test data to demonstrate the use of the prototype. These use unclassified terrain and the unclassified vehicle model supplied by Sims-R-Us. The OBF have sufficient expertise to modify the test data should it be necessary to define classified scenarios to support evaluation. There is no need to integrate the trainer with the classified communications and situational awareness systems used by the OBF.

Lesson: Security accreditation and clearances. The security-related issues associated with use of a COTS product must obviously be confirmed before the product is used on a TDP or a delivery project, which in the worst case may lead to a need for formal security accreditation. Projects must consider whether the vendor organization has staff with the necessary security clearances to provide appropriate technical support. If the vendor lacks such staff, this will limit the extent to which the vendor can be involved in project-related discussion or support (Clapp J.A., Taub A.E. 1988) and may raise the level of technical skills required by the project team (e.g., to configure or operate the product).

A COTS CHECKLIST

Many potential COTS issues can be qualified, managed or avoided simply by asking the right questions at the outset of a project that intends to adopt a COTS-based approach. To help potential COTS users to ask the right questions, we have compiled a COTS checklist. It is not claimed to be complete and exhaustive, nor is it intended to replace the extensive checks and balances defined within the formal acquisition process. However, it may help to avoid potential problems being encountered at a later stage, especially in contexts such as 'horizon scanning' when formal acquisition processes may not yet have been established. This checklist may also help staff to develop structured lists of issues to discuss with vendors and thus avoid a piecemeal approach to such contacts.

The questions are written such that "no" or "don't know" answers indicate potential issues and risks that may need to be considered further and explored with experts in the field. The questions have not been prioritized since it is considered important to check all of them to avoid apparently minor risks being missed and later escalating into significant problems. Note that although the severity of the risks (should they manifest) is project-dependent, in the worst case they can lead to significant cost or schedule overruns, safety violations or legal actions. For this reason, potential COTS users should use the checklist to examine areas outside their normal areas of knowledge (so that technical experts, for example, should check for safety or compliance issues).

Table 1. A COTS Checklist

Area	Questions
Requirements	• Does the flexibility exist to vary user requirements to match COTS product capabilities? • Do the requirements specify performance parameters that are unlikely to be met by a COTS product? • Are requirements written in a solution-independent way that could be met by more than one potential product? • Are requirements written to be unambiguous, precise and measurable (for example, is the desired simulation fidelity understood and agreed by the users and the suppliers)? • Are existing COTS products known that can potentially meet the requirements (i.e., do the requirements reflect the 'art of the possible')?

Safety	• Is the COTS product intrinsically safe to use (e.g., standalone software with no moving parts, lasers, etc)?
	    o *If 'no', will all potential users have training in the safe use of the COTS product?*
	• Will the COTS product be used only in a safe environment?
	    o *If 'no', can the proposed environment be made safe by appropriate remedial work?*
	• Do the answers to the above hold true for all proposed uses of the project (e.g., demo by contractor followed by unattended trial)?
	• Can the vendor provide evidence for the safety of the product relevant to the legislation in force in the country in which the product will be used?
	    o *If 'no', what steps can be taken to generate the appropriate evidence?*

Compliance	• Can the vendor provide evidence for legislative compliance requirements (such as CE Marks in the case of Europe? ○ *If 'no', what steps can be taken to generate the appropriate evidence?* • If the product is foreign, does the vendor have the appropriate permission to export? • If the product may be covered by ITAR, has an 'ITAR empowered official' within the vendor organization confirmed the specific aspects affected? • Is the product free of ethical constraints (imposed by the vendor) that limit its use in military contexts?
Commercial	• Is a single organization involved in integrating/building the product (as opposed to a complex multi-organization supply chain) • Is it clear who holds the risk for any integration activities that are conducted? • Is it clear which body has the 'design authority' to say that the complete integrated system is safe, secure, etc and is the body competent to do so? • Does the user have appropriate licenses for use of the product or the supporting products on which it in turn depends? • Is ownership of IPR clear across the entire supply chain? • Does the contractual framework have the necessary flexibility / agility to allow for changes such as substitution of one product for another?
Technical	• Is the product supported by appropriate technical information (notably functional and performance specifications, Interface Control Documents, etc.) that is accessible to the authority and other relevant parties? • If a product contains mathematical or other models that will be used in a Test and Evaluation role (e.g., to generate evidential data), are descriptions of the relevant algorithms available to support accreditation? • Has the product already been used in a truly representative military environment (i.e., does it have a relatively high TRL)? ○ *If 'no', is there evidence that the product able to fulfil its intended roles / functions, for example vendor-independent test results or performance benchmarks?* • Does the product allow third party customization (e.g., scenario definition) without vendor participation? • Is there evidence to show that the COTS product can be integrated (if necessary) with third party systems? • If multiple COTS products are to be integrated, is there evidence that the proposed combination or configuration has been successfully achieved by other projects or users? • If it intended to conduct technical integration, is there evidence to show that the overall system architecture and/or legacy systems can in fact accept COTS inserts? • Can MOD provide data in the formats required by a COTS product? • If modifications to the COTS product are required, are the vendor's development processes demonstrably robust (e.g., ISO9001-certified)?
Through-life issues	• If a product requires consumables, spare parts or servicing, have these been considered in project budgets and schedules? • Have the 'in-service' support and disposal needs of the product been considered? • Will the vendor be able to provide technical support at a suitable level (e.g., telephone helpdesk vs. on-site engineer) as and when required by the project? • Will industry continue to commercially support the product (or its underlying hardware and software) for the lifetime of the project/system within which it will be used? • Is the vendor's proposed product upgrade path known? • Can the product upgrade path (if known) be aligned with relevant project phases? • Are the full licensing needs known from the outset of the project?

Security	• Is the proposed use of the product free from security issues?
	  ○ *If 'no', do project costs allow for formal accreditation?*
	  ○ *If 'no', is the product suitable for use in a classified environment?*
	• Does the product vendor have staff with appropriate security clearances to provide technical support activities if required (such as loading weapon or sensor performance data)?
	  ○ *If 'no', are the technical skills necessary available to the project team?*

Miscellaneous	• Have the training needs of COTS product users been considered? • Are the 'business processes' (e.g., system workflows) implemented by the COTS product compatible with existing ways of working? • Is the existing infrastructure (space required in building, attachment points, power supplies, safety systems, etc) suitable for installation of the product? • Will the product be independent of other systems in the building (fire alarms, etc)? • Does the vendor supply user manuals suitable for field use by the likely operators or administrators of the system? Do these cover important start-up, shutdown, maintenance and safety issues?

CONCLUSIONS

Projects that use COTS products potentially have several advantages over those that develop custom solutions, including low initial cost of acquisition, and an ability to quickly adopt new or disruptive technologies. However, there can be many different technical, commercial and legislative challenges associated with moving 'from COTS to capability', and low initial costs may be offset by unanticipated through-life expenditure.

Many COTS risks can be avoided (or at least better mitigated) simply by asking appropriate questions when the use of a given COTS product is initially considered. A short COTS checklist has therefore been compiled on the basis of the issues considered during this study, and which covers a range of topics across typical project lifecycles. It is intended to help potential COTS users to 'avoid surprises' and to better understand some of the potential hidden costs of COTS, helping them to realize the true benefits of COTS.

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