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2026

# DIVERSION DIGEST

**Faster, Higher, Further**

Tracking non-state armed group modifications to uncrewed aerial vehicles

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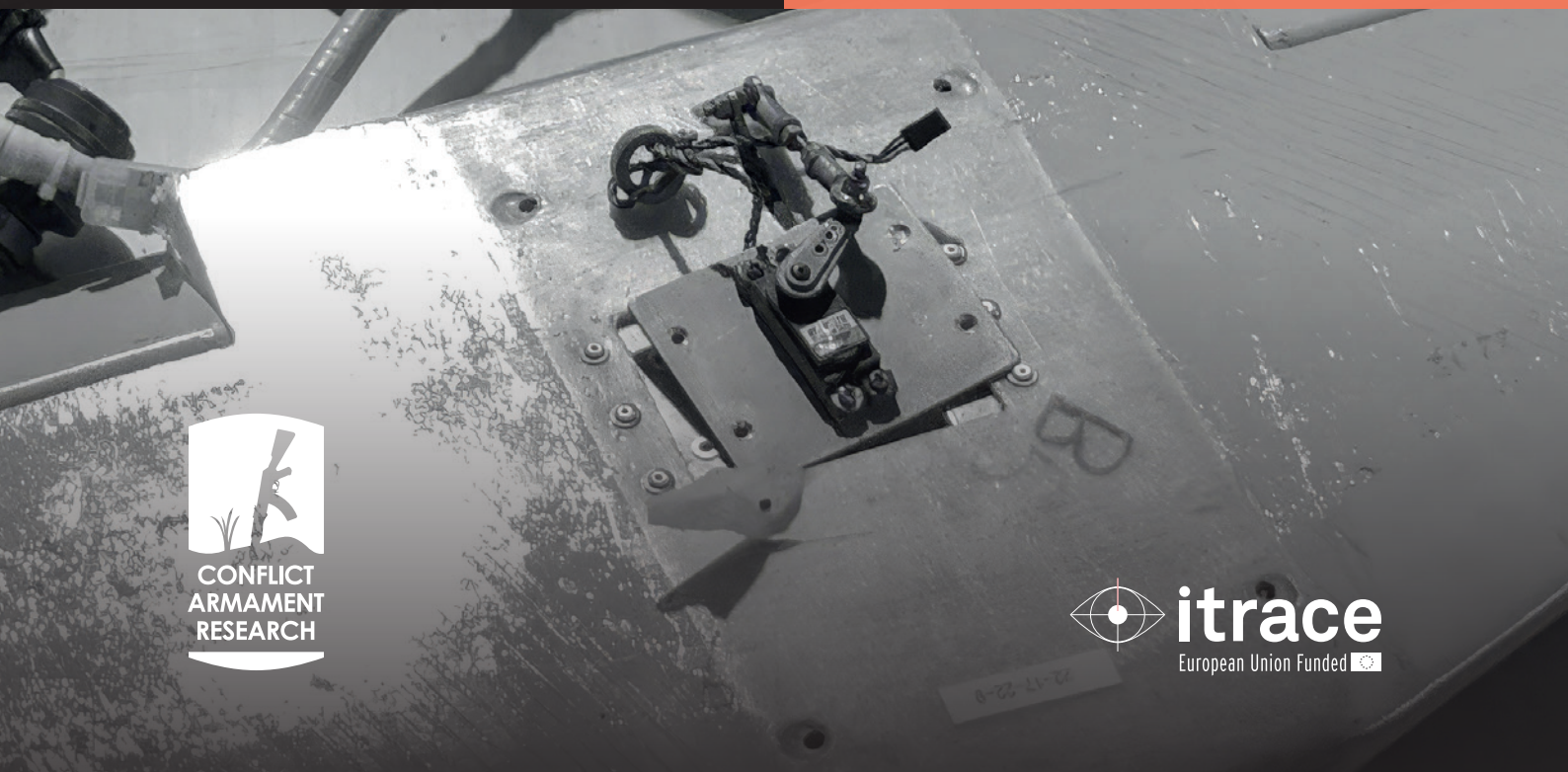


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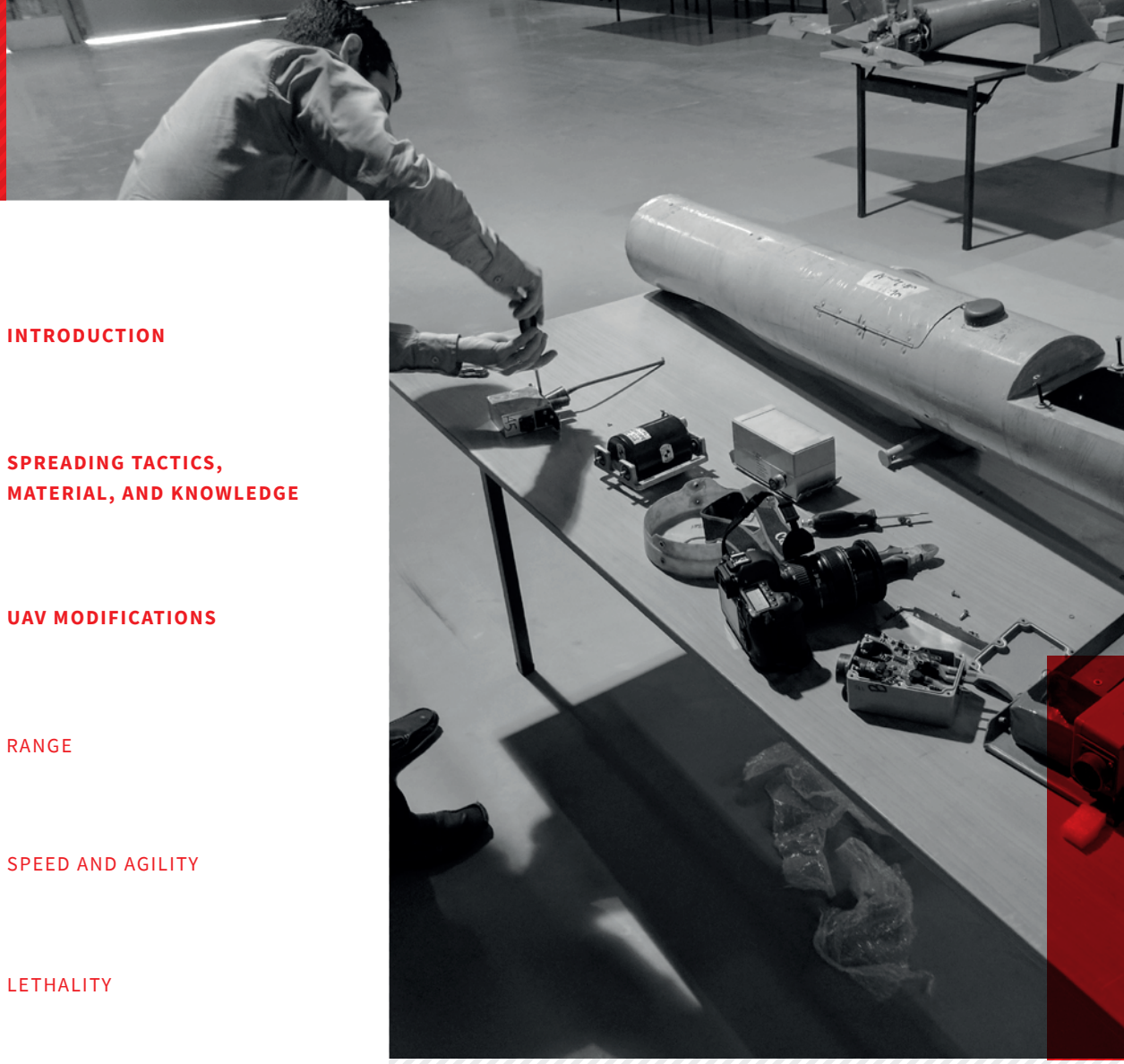




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Front cover image: A Qasef-1 UAV recovered from Houthi forces in Yemen and subsequently documented by CAR field investigators in February 2017.

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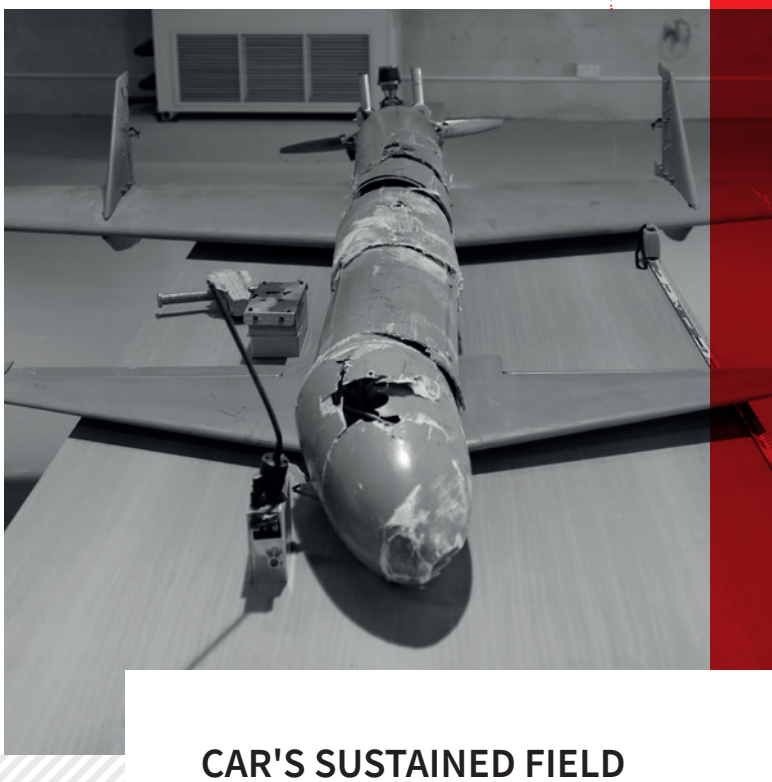
# INTRODUCTION

From the moment uncrewed aerial vehicles (UAVs)[1] became a viable option for designated terrorists, criminal organisations, and other non-state armed groups, Conflict Armament Research (CAR) investigators have been at the forefront of efforts to understand the threat posed by this technology. Through sustained field and tracing engagements across diverse conflicts, CAR is uniquely positioned not only to identify the emergence of new threats as they arise, but also to track their development over time.[2]

CAR's exposure to UAVs in its field operations has largely mirrored the evolution and proliferation of these systems, particularly their adoption by non-state armed groups. When CAR was founded in 2011, possession and use of UAVs was almost entirely limited to state militaries. Confirmed examples of armed groups successfully deploying UAVs were extremely rare, and their deployment was limited to short-range surveillance. Today, the threat posed by the non-state use of UAVs nears the top of the international security agenda (UNSC Counter-Terrorism Committee, 2022). Uncrewed systems are present in many of the contexts in which CAR operates; CAR field teams and data collectors have now documented UAVs and their components in ten conflict-affected countries, including Iraq, Libya, and Yemen.

CAR investigators document and assess technical changes in the capability of UAVs recovered from illicit armed actors. They examine any modifications that might increase the range, speed, or lethality of a UAV, as well as its accuracy or its ability to defeat or evade technical countermeasures. As this report demonstrates, the sustained nature of CAR's field engagements has allowed its investigators to track such evolutions and the emergence of new threats.



A Qasef-1 UAV recovered from Houthi forces in November 2016, and subsequently documented by CAR.

**CAR'S SUSTAINED FIELD DOCUMENTATION ENABLES IT TO TRACK HOW UAV THREATS EVOLVE OVER TIME—FROM EARLY NON-STATE ADOPTION TO THE INCREASINGLY CAPABLE SYSTEMS TODAY.**

## ABBREVIATIONS

**CAR**
Conflict Armament Research

**FPV**
First-person-view

**IED**
Improvised explosive device

**ISIL**
Islamic State in Iraq and the Levant

**TTP**
Tactics, techniques, and procedures

**UAS**
Uncrewed aerial system

**UAV**
Uncrewed aerial vehicle

**UUV**
Uncrewed underwater vehicle

# SPREADING TACTICS, MATERIAL, AND KNOWLEDGE

The performance capabilities of commercial UAVs have steadily increased over the past 15 years, as technological developments have enabled greater range, flight time, speed, and manoeuvrability. Individual components such as power sources, cameras, and navigation modules have similarly matured. Production costs have dropped, as has the market price, meaning that many of these products are widely available.

As access barriers fall away, non-state armed actors are increasingly able to modify or customise UAVs in their possession—particularly by adding a weapon delivery capability. In some cases, actors aim to produce their own systems from scratch (Dulligan et al., 2023). The result is that non-state armed groups are deploying more lethal UAVs, characterised by longer ranges, faster speeds, and enhanced agility.

The rapid uptake of UAVs by non-state armed actors has been enabled by the spread of tactics and know-how between groups and across conflicts. In some instances, this spread is deliberate and strategic. United Nations sanctions monitors note, for example, that forces associated with Islamic State West Africa Province carried out their first weaponised UAV attack in December 2024 in the Lake Chad border area—directly following the arrival of 13 specialist trainers from affiliates in the Middle East (UNSC, 2025, para. 25).

**CAR DOCUMENTED FIVE FIBRE-OPTIC FIRST-PERSON-VIEW UAVS THAT WERE CLEARLY DESIGNED TO MIRROR TTPS FIRST DEVISED IN THE CONFLICT IN UKRAINE.**

Non-state armed groups also attempt to replicate proven tactics, techniques, and procedures (TTPs) they observe in other conflict contexts. In May 2026, a CAR field investigation team in the Middle East documented five fibre-optic first-person-view (FPV) UAVs that were clearly designed to mirror TTPs first devised in the conflict in Ukraine (see Figure 1). Each of the five UAVs was custom-built, highly standardised in construction and component layout, and weaponised to carry an explosive payload. All were fitted with a fibre-optic spool to permit them to receive command and control inputs physically through the fibre link—and thus to bypass countermeasures based on radio-frequency communications.

FIGURE 1

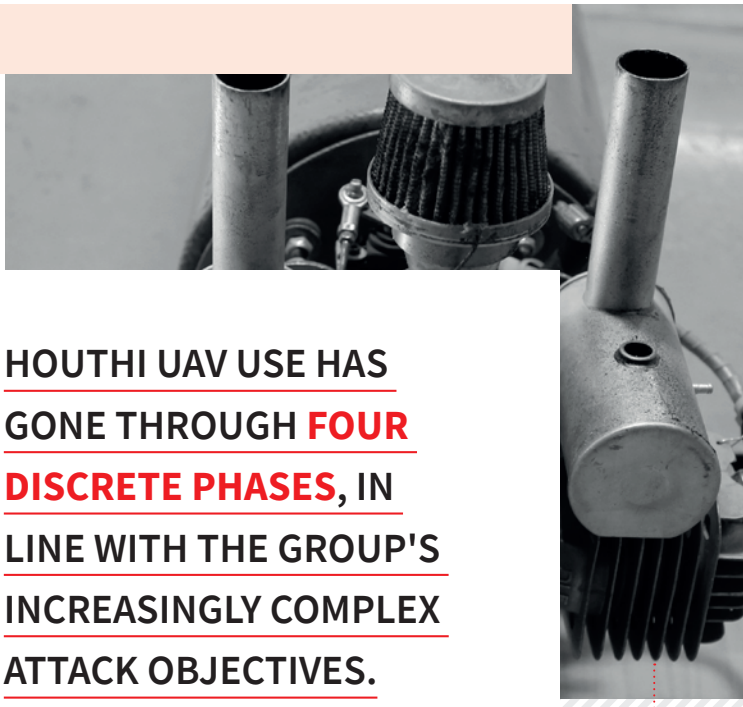
**CAR INVESTIGATORS INSPECTING AN FPV UAV FITTED WITH A FIBRE-OPTIC SPOOL**

11 MAY 2026

# UAV MODIFICATIONS

## RANGE

Range is a significant threat indicator through which analysts may understand the capabilities of non-state armed groups, particularly as continued innovation can be expected in this area. Over the past decade, CAR investigators have tracked the evolution of technical capabilities available to Ansar Allah ('Houthi') forces (CAR, 2020b). During this period, Houthi UAV use went through four discrete phases, in line with the group's increasingly complex attack objectives (see Figure 2). While first-generation models such as the Qasef-1 were rudimentary and limited to short-range one-way attacks (phase 2, first observed in 2016), more recent systems are far more powerful, enabling long-range attacks on critical economic and energy infrastructure in the wider region (Hambling, 2021; Nevola and d'Hauthuille, 2024).

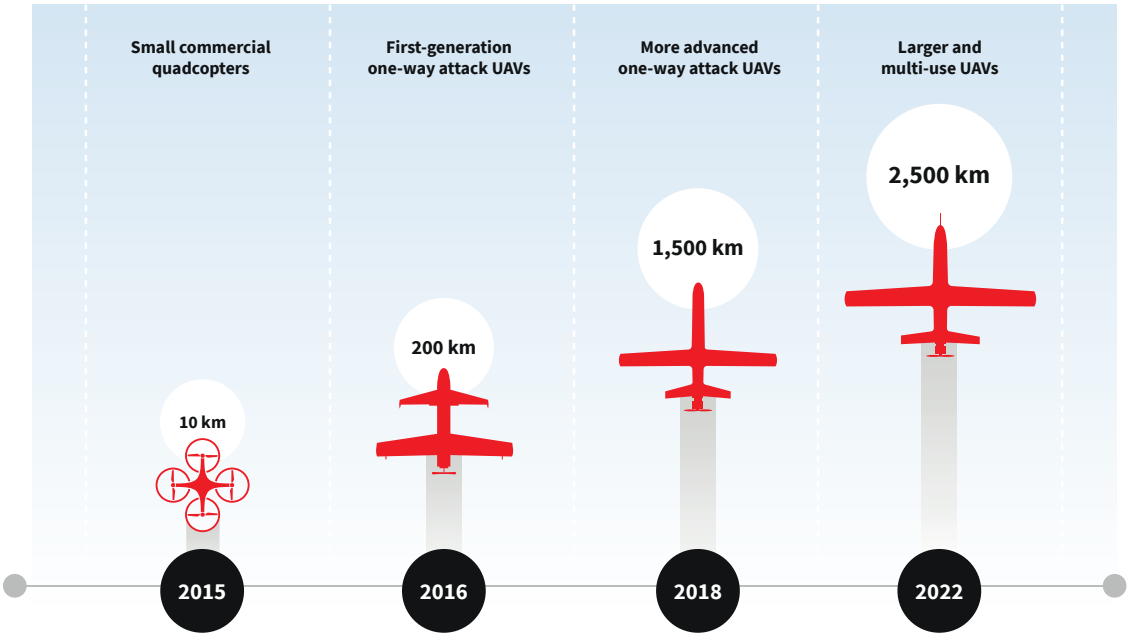


Two-cylinder petrol engine documented by CAR in a Houthi UAV.

**HOUTHI UAV USE HAS GONE THROUGH FOUR DISCRETE PHASES, IN LINE WITH THE GROUP'S INCREASINGLY COMPLEX ATTACK OBJECTIVES.**

FIGURE 2

**PHASES OF HOUTHI UAV USE AND THEIR FIRST APPEARANCE IN THE CONFLICT IN YEMEN**



## RANGE (CONTINUED)

Servomotor gears on the tail fin of a hybrid Qasef-1 UAV recovered from Houthi forces and documented by CAR.

**THE CARBON-FIBRE TANKS WERE FALSELY LABELLED AS 'OXYGEN CYLINDERS'—BUT ACTUALLY CONTAINED HYDROGEN FOR USE IN FUEL CELL SYSTEMS.**

CAR's frontline investigations in Yemen have further uncovered Houthi efforts to adopt and adapt new commercial offerings to augment existing systems (Hinz, 2025). In November 2024, investigators documented evidence that Houthi forces were attempting to use hydrogen fuel cells to power their uncrewed systems (CAR, 2025c). A CAR field team deployed to the port city of Mokha to document cargo that security personnel had seized aboard a trading vessel in the southern Red Sea on 3 August 2024. The vessel had been on route to the Houthi-controlled port of Salif on Yemen's western coast.

The cargo contained a mix of undeclared components, including several 9-, 12-, and 20-litre pressurised gas tanks. The carbon-fibre tanks were falsely labelled as 'oxygen cylinders' (see Figure 3). Documents recovered with the gas tanks clearly indicate that they actually contained hydrogen, and that they were intended for use as part of fuel cell systems for UAVs.

FIGURE 3

**MISLABELLED HYDROGEN CYLINDERS**

DOCUMENTED BY CAR / MOKHA, YEMEN / 12 NOVEMBER 2024

Interdiction of the *Al Sherwa* from which CAR documented Houthi-bound components likely intended for use with one-way attack UUVs.
*Source: © US Central Command*

CAR's documentation was the first public disclosure of Houthi efforts to modify uncrewed systems to extend their range. If successful, these attempts would represent a major escalation in Houthi capability. Compared to some other power sources, such as traditional lithium batteries, hydrogen would enable uncrewed vehicles to travel for far longer periods and across far greater distances. Compressed hydrogen gas and liquid hydrogen fuel cells can also be used in uncrewed underwater vehicles, or UUVs (Bajon and Grand-Clément, 2023). In June 2025, CAR investigators documented several components aboard a shipment of material intended for the Houthis that were most probably intended for one-way attack UUVs (Figure 4) (CAR, 2026).[3]

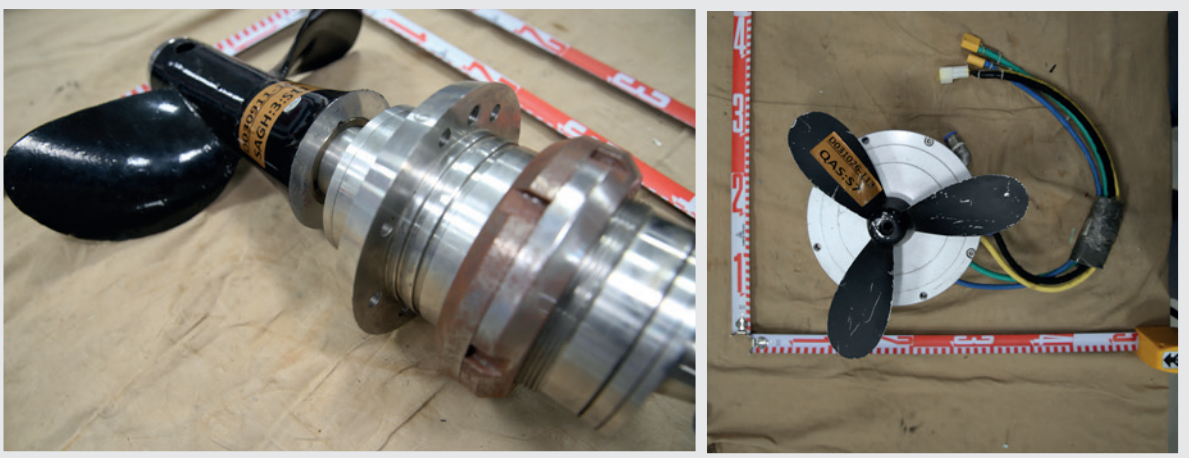
Uncrewed systems powered by hydrogen are a novel technology and a recent commercial offering (Rassler, 2024). Houthi attempts to use hydrogen fuel cells to extend the range of their UAVs therefore spotlight the speed with which non-state armed groups may seek to integrate commercial capabilities into locally produced or modified systems.

**CAR'S DOCUMENTATION WAS THE FIRST PUBLIC DISCLOSURE OF HOUTHI EFFORTS TO MODIFY UNCREWED SYSTEMS TO EXTEND THEIR RANGE.**

FIGURE 4

**TWO- AND THREE-BLADED MARINE PROPELLORS, RECOVERED ONBOARD THE AL SHERWA DHOW IN THE SOUTHERN RED SEA**

DOCUMENTED BY CAR / YEMEN / JUNE 2025



## SPEED AND AGILITY

While range determines a UAV's threat reach, the nature of that threat is shaped by the UAV's speed and agility. Modifications that change how a UAV moves greatly influence its ability to carry out attacks.

CAR investigators operated across Iraq throughout the period that forces associated with Islamic State in Iraq and the Levant (ISIL) controlled vast swathes of territory and resources in the country (CAR, 2017b). During this time, ISIL ran a dedicated UAV development programme and CAR field teams tracked the group's efforts to develop or modify UAVs (CAR, 2016). CAR determined that ISIL technicians had at one stage sought to develop larger, faster UAVs powered by pulsejet engines. A pulsejet is an inexpensive and technically unsophisticated jet engine, capable of generating approximately 220 N (50 lbs) of thrust and achieving speeds of 250 km/h or more. ISIL procurement agents sought to purchase online plans for these engines, utilising a network of fake employee identities (CAR, 2020c).

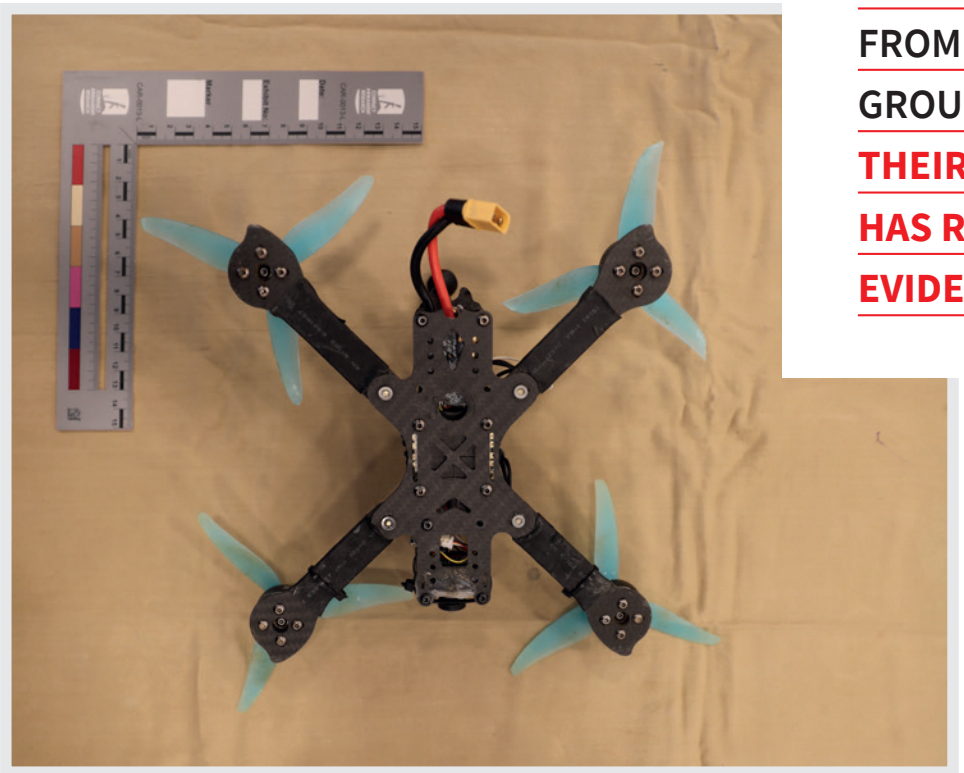
CAR rarely encounters such efforts to modify UAV flight capabilities, which may in part be due to the rapid advances in the speed and agility of small UAVs that can easily be acquired on commercial markets. This is especially notable with the rapid adoption of FPV UAVs.[4] FPVs allow an operator to carry out precision attacks at speeds of up to 160 km/h, bypass traditional defences, and access areas that are off limits to traditional 'hovering' quadcopter UAVs, such as building interiors (Sabbagh, 2025).

Until 2024, CAR had not encountered any FPV UAVs recovered from non-state armed groups in its fieldwork. Since then, their proliferation has rapidly become evident. CAR field investigators have now seen FPV UAVs recovered from armed groups in six of its ongoing conflict operations, including in Libya (see Figure 5). While CAR's documentation of this technology remains relatively rare, it is clear that FPV UAVs are no longer restricted to the battlefield in Ukraine but are fast becoming an option for other actors globally.

FIGURE 5

**A CUSTOM-BUILT FPV UAV**

DOCUMENTED BY CAR / LIBYA / 28 JANUARY 2025



**UNTIL 2024, CAR HAD NOT ENCOUNTERED ANY FPV UAVS RECOVERED FROM NON-STATE ARMED GROUPS — SINCE THEN, THEIR PROLIFERATION HAS RAPIDLY BECOME EVIDENT.**

A pulsejet engine recovered from ISIL forces and documented by CAR in Iraq in 2017.

FPV UAVs are operated by a pilot using video goggles to view a live feed from the UAV's onboard camera.
*Source: iStock*

In some contexts, CAR documented these UAVs without an integrated explosive payload, suggesting that they had served a reconnaissance role. As discussed in the next section, however, some FPV UAVs inspected by CAR field teams have been modified to deliver explosive payloads, either through the repurposing of conventional ordnance or the attachment of release mechanisms to deliver improvised munitions in flight.

FPV UAVs integrate commercially available components, each of which provides CAR with a possible entry point to trace, map, and understand their proliferation among non-state armed groups. CAR has identified manufacturers and models of FPV UAV components—such as motors and flight controllers—that are points of commonality across otherwise unrelated operations. These companies are making and selling products designed primarily for the hobbyist and other unrelated markets and CAR alleges no wrongdoing on the part of the companies supplying these sectors. Nevertheless, CAR's investigations indicate that both national militaries and non-state armed groups are repurposing commercially available components for military end use, invariably without the manufacturer's awareness or authorisation. CAR has identified this trend across its global investigations (CAR, 2025b).

Trace operations have highlighted that since some of these manufacturers are unaware of this risk of misuse, they do not adopt practices that would enable downstream controls or traceability of their products. One such company—a producer of a video transmitter that CAR documented in an FPV UAV in Syria in 2024—informed CAR that it had been unable to identify the precise supply chain for its product because it had maintained the same batch number since 2019. The company further stated that while it had previously maintained this practice because of concerns over production costs and quality control, it would implement sequential batch numbering and date marking for future production.

**NATIONAL MILITARIES AND NON-STATE ARMED GROUPS ARE REPURPOSING COMMERCIALLY AVAILABLE COMPONENTS FOR MILITARY END USE, WITHOUT MANUFACTURER'S KNOWLEDGE.**

## LETHALITY

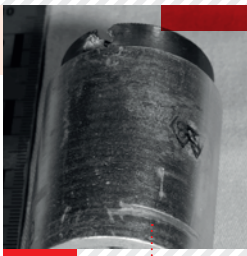
Modifying UAVs to carry an explosive payload remains a common weaponisation objective for non-state armed groups (CAR and UNOCT, 2024). Such weaponisation is by no means a new phenomenon. CAR field teams previously tracked ISIL forces as they undertook the 'weaponisation at scale' of commercial off-the-shelf quadcopter UAVs across Iraq. UAVs documented in Iraq featured a release mechanism consisting of an empty silicon sealant tube fixed to the underside of the craft (see Figure 6). The tube housed a modified 40 mm spin-stabilised grenade that could be released via a servo motor fitted to the UAV (CAR, 2017a).

**CAR FIELD TEAMS TRACKED ISIL FORCES AS THEY UNDERTOOK THE WEAPONISATION AT SCALE OF COMMERCIAL OFF-THE-SHELF QUADCOPTER UAVS ACROSS IRAQ.**

FIGURE 6

**A QUADCOPTER UAV, MODIFIED TO DROP IMPROVISED WEAPONS**

DOCUMENTED BY CAR / IRAQ / 2017



Modified North Korean submunition adapted to be attached to an FPV UAV, documented by CAR in 2025.

FIGURE 7

**A 3D-PRINTED RELEASE MECHANISM, ATTACHED TO THE UNDERSIDE OF A COMMERCIAL UAV**

DOCUMENTED BY CAR / SYRIA / 2023

Since 2023, CAR field investigators have documented isolated examples of modifications to increase UAV lethality through 3D printing. This method remains rare in CAR's global data. In one example, CAR documented a commercial quadcopter UAV in Syria that featured a 3D-printed release mechanism (see Figure 7). CAR has observed government forces employing similar tactics and technology. Russian forces, for instance, have utilised 3D printing to allow FPV UAVs to carry explosive payloads. In October 2025, a CAR field team documented a North Korean submunition that had undergone a set of crude alterations—including the replacement of an arming and stabilisation mechanism with a 3D-printed detonator holder—so that it could be attached to an FPV UAV (CAR, 2025d).

**CAR HAS OBSERVED GOVERNMENT FORCES EMPLOYING SIMILAR TACTICS AND TECHNOLOGY —INCLUDING UTILISING 3D PRINTING.**

## LETHALITY (CONTINUED)

FIGURE 8

**REMNANTS OF AN FPV UAV WITH A 40 MM ROCKET WARHEAD**

DOCUMENTED BY A CAR DATA COLLECTOR / SYRIA / 27 JULY 2024

CAR has also documented attempts by non-state armed groups to fit FPV UAVs with explosive payloads. In July 2024, for example, CAR documented the remnants of an FPV UAV in Syria that included the warhead section of a 40 mm rocket (see Figure 8). Investigators identified the original producer of the rocket from visible markings on the warhead. Having successfully traced it with the relevant export authority, CAR established that the rocket had been transferred to a government defence ministry in the region, although the item's onward chain of custody and subsequent diversion to its eventual end use remain unclear.

**CAR DOCUMENTED NON-STATE ARMED GROUPS FITTING FPV UAVS WITH EXPLOSIVE PAYLOADS, INCLUDING A ROCKET TRACED TO A GOVERNMENT DEFENCE MINISTRY.**

Whereas weaponised quadcopter UAVs typically drop explosives from a position above a target, FPV UAVs can be flown towards a target, greatly changing the threat capability available to non-state armed groups. Such UAVs typically carry relatively small, light ordnance, such as grenades or rockets.

Across its global operations, CAR has documented improvised weapons and improvised explosive devices (IEDs) that incorporate unsecured or abandoned conventional ammunition (CAR, 2024). Once lost, stolen, or otherwise diverted from a legal custodian, such ammunition can be repurposed to weaponise UAVs. In many of the conflict- and terrorism-affected countries in which CAR works, government forces face challenges in maintaining effective control over the security of conventional ammunition—including grenades, mortars, mines, and rockets—heightening the risk of diversion to non-state armed groups.

# COUNTERING UAV WEAPONISATION

The breadth of possibilities available to non-state armed groups makes UAV modification and weaponisation extremely challenging to counter. As with other forms of improvised weapon development that draw on commercial and non-controlled materials, measures taken to ensure supply chain integrity can help to mitigate threats or prevent them from evolving (CAR, 2024).

CAR's experience in tracking and tackling the diversion of materials used in the manufacture of improvised weapons and IEDs consistently points to two linked approaches as central to the development of effective policy measures: long-term field monitoring and the targeting of critical supply chain chokepoints.

## LONG-TERM FIELD MONITORING

Sustained field monitoring ensures that policy and technical responses to the UAV threat posed by armed groups are informed by evidence and adapt to changes over time. In this context, the absence of evolution can be as instructive to investigators as its presence, since it may highlight technical limitations, acquisition bottlenecks, or established TTPs.

A case in point involves a Rased-series UAV that a CAR field team documented in Yemen in November 2024, following its deployment by Houthi forces in Taiz governorate earlier that month. The Houthis have modified Rased UAVs to transport small items, typically for intelligence, surveillance, targeting, or reconnaissance purposes. To check for any changes in methods or technology, CAR compared the UAV examined in 2024 with the first one it had documented, four years prior.

In comparing the two Rased-series UAVs, CAR observed no notable evolution in the design or components used in the manufacture since 2020. Both units featured a mount on the underside of the fuselage, to which an additional payload could be secured with straps (see Figure 9). As neither UAV had a release mechanism, CAR determined that the mount may have been used to transport a payload—possibly one that would enhance the Rased's intelligence, surveillance, and reconnaissance capabilities, such as a thermal imaging camera or additional communications device.

FIGURE 9

**IDENTICAL STRAPPING ON THE MOUNT OF RASED-SERIES UAVS**

THE UAV ON THE LEFT IS CARRYING A PACKAGE CONTAINING SMALL-CALIBRE AMMUNITION

DOCUMENTED BY CAR / YEMEN / 2020 (LEFT) AND 2024 (RIGHT)

## TARGETING SUPPLY CHAIN CHOKEPOINTS

Successful UAV weaponisation requires access to knowledge, tools, and materials. Each of these requirements constitutes a possible 'chokepoint' for disrupting and inhibiting weaponisation efforts (CAR and UNOCT, 2024, p. 42). Denying unauthorised actors access to the materials they need to increase UAV capabilities is the bedrock of any coordinated 'upstream' approach to preventing the illicit use of UAVs (UNOCT et al., 2022).

Many of the components that CAR documents in UAVs—whether recovered from non-state armed groups or from military forces that are subject to sanctions or restrictive measures—are small electronics that are widely available on the open market (CAR and Hayes, 2025). Some of these components can be used to modify existing systems, either to extend their threat capabilities or to allow them to evade electronic countermeasures (CAR, 2025a). CAR is yet to document commercial electronics in non-state armed group UAVs that might provide artificial intelligence capabilities, for example related to targeting or navigation. Such capabilities are available on commercial markets, however, and have been integrated into military UAVs that CAR recently documented.

Multipurpose components can be used in a wide variety of products, but licensing controls are not typically triggered until an item is known to have a potential military end use. Grounded field data and analysis is therefore critical, not only to help close regulatory gaps, but also to inform effective risk identification for specific sensitive technologies.

**DENYING UNAUTHORISED ACTORS ACCESS TO THE MATERIALS THEY NEED TO INCREASE UAV CAPABILITIES IS THE BEDROCK OF ANY COORDINATED 'UPSTREAM' APPROACH TO PREVENTING THE ILLICIT USE OF UAVS.**

Remnants of a hybrid Qasef-1 UAV recovered from Houthi forces in Yemen and documented by CAR in 2018.

Formal tracing of these commercial components is the most effective way to identify how diversion has occurred (CAR, 2020a). CAR has more than a decade of experience in tracing illicit weapons and ammunition and has successfully extended its methodology to the supply chains of commercial items, including UAV components. If supply chains are sufficiently diffuse to pose a challenge to traditional tracing operations, CAR overlays responses from different partners to identify common intermediaries, which sometimes recur across different component types. CAR investigators also draw on diverse sources—including bill-of-lading-level trade data and corporate registries—to map the procurement networks behind the supply of these components. By applying this multilayered approach across its investigations, CAR has developed deep insights into the varied ways in which unauthorised users seek technology to build their UAV capacities.

Even the most localised production efforts require access to commercial components, presenting opportunities for early interventions to choke off acquisition attempts. When a CAR field team in Iraq in 2016 encountered an ISIL workshop employed for UAV production—including the manufacture of airframes from plywood and foam used in insulation boards—investigators also documented bulk supplies of resistors, transistors, signal relays, and other hardware, all of which could be traced (CAR, 2016). By alerting manufacturers to the misuse of their products, and governments to potential gaps in export controls, CAR's work informs commercial and regulatory decision-making, supports the sanctioning or 'red-flagging' of entities engaged in component diversion, and highlights elevated risks associated with high-priority components.

Sample of cargo documented by CAR investigators that NRF seized from Al-Zahra 1.

# CONCLUSION

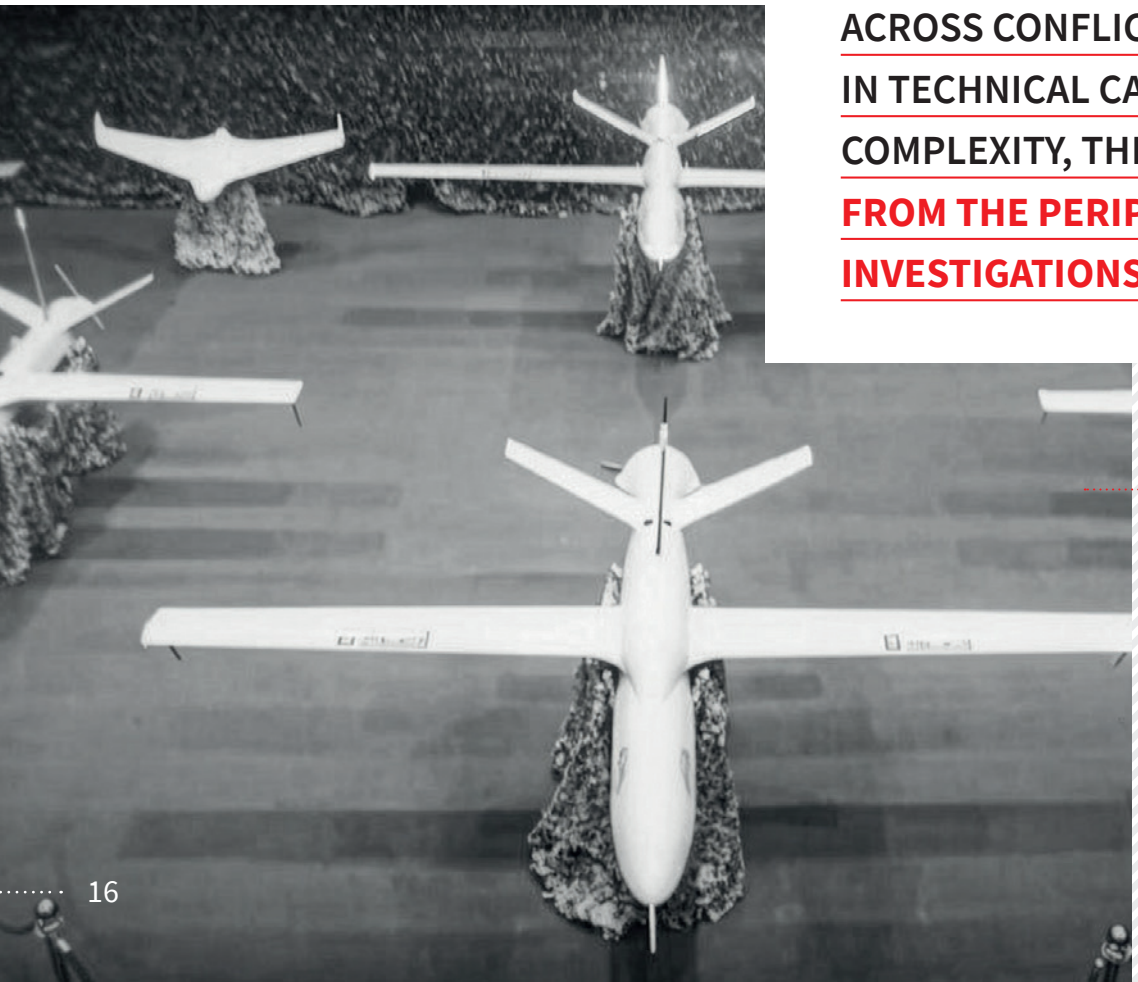
As UAVs have proliferated across conflicts and have grown in technical capability and complexity, they have moved from the periphery of CAR's investigations to the core. These investigations highlight how a decline in access barriers, the rapid adoption of commercial trends and new products, the identification of low-cost solutions to resource challenges, and the spread of tactics and knowledge from other conflicts have enabled non-state armed groups to acquire and weaponise UAVs.

States have increasingly sought to develop political and operational toolkits to address the threat of UAV proliferation among terrorists and other non-state armed groups. In 2023, the UN Security Council Counter-Terrorism Committee issued the Abu Dhabi Guiding Principles on countering the use of new and emerging technologies for terrorist purposes. These principles specifically call on UN member states to develop regulations that provide control over UAVs and their components—and to encourage industry stakeholders to exercise strict due diligence in the transfer of such items (UNSC, 2023).

Controlling component access starts at the very top of the supply chain. Anticipating the potential end uses of multipurpose commercial products is a more complex task than doing so with respect to conventional weapons and ammunition. It is also highly reliant on grounded field data to evidence which components are most vulnerable to diversion and how that diversion is happening.

Effective disruption efforts thus require precise, verified evidence. Supply chain integrity depends on insights into what illicit actors seek to acquire and how to stop them from doing so. Through detailed documentation and technical analysis of recovered systems, field monitors such as CAR provide an evidence base against which authorities can develop targeted interventions, including by identifying supply chain weaknesses that provide access to sought-after components.

**AS UAVS HAVE PROLIFERATED ACROSS CONFLICTS AND GROWN IN TECHNICAL CAPABILITY AND COMPLEXITY, THEY HAVE MOVED FROM THE PERIPHERY OF CAR'S INVESTIGATIONS TO THE CORE.**



Houthi-produced UAVs on display at an exhibition in Sanaa, Yemen, 7 July 2019. *© Yemen Press*

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# ENDNOTES

1 An uncrewed aerial system (UAS) comprises both the aircraft and its associated elements, including the ground control system or controller. Since CAR field investigation teams typically encounter the physical aircraft component of a UAS, the term 'UAV' is more appropriate in the context of CAR operations.

2 In 2024 CAR and the United Nations Office of Counter-Terrorism Autonomous and Remotely Operated Systems Programme published a global study on how non-state actors acquire, weaponise, and deploy UAVs (CAR and UNOCT, 2024).

3 CAR has no evidence to link the hydrogen cylinders discovered in 2024 to these components.

4 While long available to hobbyists, the use of FPV UAVs in the conflict in Ukraine in particular has been hailed as a 'true game-changer' in the war in Ukraine (Rassler and Veilleux-Lepage, 2025).

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