Remote Weapon Systems: The Next Generation

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ABSTRACT

The popularity and proliferation of remote weapon systems [RWS] in the past decade has been based largely on improved gunner security and enhanced firepower. We discuss the evolution of 1st generation RWS and trends emerging, with the following key thrusts:

1. **Urban warfare enhancements**. Recent operations have driven enhancements such as situation awareness, short-range engagement, wider weapon and sensor fields, and higher weapon elevation angles.
2. **Integrated operations cutting across older roles**. New RWS use technology to deliver an integrated capability for detection, surveillance, monitoring, suppression, area denial, and focused firepower.
3. **Weapon flexibility**. Emerging RWS mount dual weapons to provide operational flexibility, and support new payloads such as non-lethal weapons, missiles or directed-energy weapons with enhanced effectiveness due to superior [RWS] sensors.
4. **Counter terrorism and counter insurgency**. RWS found early application in CT operations in urban clutter, scanning for insurgents embedded in crowds, and counter-sniper operations.
5. **CIED operations**. The extreme accuracy of RWS is used for kinetic kill of many IED species, and directed-energy IED kill systems which provide higher confidence in disabling of IEDs are already emerging. A role in IED detection is emerging.
6. **Training and simulation.** The rate of change of technology, capability and operational doctrine is accelerating and emerging RWS include embedded training and simulation tools to accelerate effective operational uptake.

First generation RWS have already had a major impact on combat operations, and ongoing developments to improve and enhance first-generation capabilities continue. The original performance and application expectations for RWS have been exceeded.

Meanwhile next (second) generation RWS are poised to make an even stronger impact. These 2nd generation RWS will be characterized by Wireless, Autonomous and Networked ("WAN") Operations that open the way to completely new capabilities.

This development will place new demands on training, doctrine, information management, and future [objective] force architecture.

1. RWS Evolution

1.1 Origins

Current remote weapon systems (RWS) owe their design architecture to a process beginning with post-Vietnam reforms, moulded by evolving doctrine, and adapted in real time through operational experience.

This process initially started with two different approaches to the modern deployment of (what had previously been) crew served weapons. Each sought to improve combat effectiveness in different ways.

- One approach sought improved firepower, based on an assumption that first-burst hit would be paramount in future conflicts.
- The other approach sought to provide gunner protection as a means of improving combat effectiveness.

The RWS of today represents the fusion of these two different approaches, enabled by unexpectedly rapid progress in cost reduction and miniaturisation of sophisticated key components.

1.2 Firepower

In the US more than a decade of post-Vietnam reviews included substantial data on the effectiveness in combat of small arms and crew-served weapons. One key conclusion was that ***existing*** direct-fire weapons could be made much more effective if the soldier could be given more confidence in achieving first-burst hit.

By 1988 this analysis had led to numerous US initiatives to improve combat effectiveness, including a Joint Services Small Arms Master Plan (JSSAMP) to address small arms and crew-served and direct fire weapons. Because "*firepower*" was of prime importance, a key focus at the outset was to achieve first-burst hit through proliferation of fire control to small arms.

By 1991 the JSSAMP had led to program initiatives including the Small Arms Common Module Fire Control System (SACMFCS). The SACMFCS concept was for manual weapon aiming, aided by a full fire control solution projected to the gunner's field-of-view. There was no requirement for gunner protection.

By 1996 SACMFCS had achieved the expected force multiplier effects, but had also demonstrated that even more effective firepower could be achieved by motorising and stabilising the weapon aiming. From here it was a short step to relocation of the gunner to under armour, with the additional benefit of providing gunner protection.

Figure 1: EOS RWS Prototype 1998.

By 1998 the shape of future RWS was emerging. The RWS shown in Figure 1 is conceptually indistinguishable from current RWS as it includes remote control, full fire control, and stabilisation.

1.3 Gunner Protection

While SACMFCS was seeking to enhance *firepower*, many operational experiences including Operation Desert Storm (1991) and the Battle of Mogadishu (1993) were highlighting the need for *gunner protection*.

In parallel with SACMFCS developments, there had been fieldings of remotely operated weapon stations during the period 1993-1997 using a variety of mechanical and electro-mechanical remote control systems.

The key objective in these programs was *gunner protection*, largely driven by more recent operational experiences. These systems were largely successful in providing gunner protection but it soon became clear that the provision of gunner safety without upgrading weapon effectiveness (accuracy) was not an optimum solution.

1.4 US Army CROWS

By 1997 a user consensus was developing that RWS should combine both firepower with gunner protection. The prior approaches were converging due to the following key developments:

A. Experience and lessons learned in (e.g.) Desert Storm (1991) and Mogadishu (1993) were applied to refine operational concepts.

B. The force multiplier effect of technology applied to existing ballistic weapons was clearly emerging. There was a clear advantage to be gained without even changing weapons.

C. Doctrine was evolving towards a digital battlefield, with implications in areas such as the use of firepower to enhance reconnaissance, integration of surveillance and lethal force, digital sensor applications, and the proliferation of computers.

D. Development programs such as SACMFCS demonstrated that manual weapon aiming could not capture all the benefits of fire control systems deployed to direct-fire weapons. A deeper commitment to technology was required to make the leap ahead.

E. New electronics and sensor technology was emerging to allow affordable implementation of both sets of requirements in a single architecture.

By 1999 the US Army had specified its RWS requirement and awarded a development contract for a Common Remotely Operated Weapon Station (CROWS 1) to EOS. This development would be overtaken by events in 2004 when pre-production units were rushed into service in operation Iraqi Freedom.

Figure 2: CROWS 1 Prototype in 2003.

From initial deployment in 2004 CROWS was fast-tracked to production and went on to become the defining 1st generation RWS, although by no means the only one. By 2010 at least 6 RWS could claim 1st generation capabiltities.

2. 1st Generation RWS

2.1 Common Attributes

The combat effectiveness of 1st generation RWS is now well established and they are rapidly deploying with land forces all around the world.

Figure 3: CROWS on Patrol in 2006.

The common attributes of successfully deployed 1st generation RWS are:

- Motorised weapon pointing and stabilisation to 1-2 mrad.
- Size/weight suited for deployment to 8x8, 6x6 and 4x4 vehicles.
- Remote controls to allow operation remotely to 10m from the weapon.
- Imaging and sensors as required to produce a full firing solution to <1 mrad in real time, for both moving and stationary targets.
- Compatible with weapons of 5.53/7.62/12.7/40 mm calibre, and capable of deploying substantial ammunition for each weapon.

2.2 Recent Enhancements

2.2.1 Unexpected Importance

1st generation RWS have assumed a more central and significant role than even their strongest proponents expected in 2000. This arises from:

- ➢ The likely absence of a top-down “Future Combat System”. The RWS now must perform new functions as needs emerge.
- ➢ The RWS has primacy on the field of regard so new roles (sniper response, RPG defence, IED detection, etc) ***must*** be consolidated into the RWS.
- ➢ The RWS is vital to the mission, and is thus a core operational asset around which new capabilities can be safely integrated.

In addition to the common attributes listed above, 1st generation RWS are evolving rapidly to meet new threats or operational requirements.

2.2.2 Urban Warfare Enhancements

The original RWS concept of operations did not specifically include urban warfare capabilities. The changes required to achieve enhanced performance in urban conflict zones are:

- Situation awareness. In close quarters a continuous awareness of the entire local situation [say] around the vehicle is critical.
- Increased weapon angular rate. Closer objects traverse the weapon field of view rapidly, even if moving relatively slowly.
- Wider sensor and weapon zones. Narrow fields of view with long-range recognition capabilities suited to long-range engagement are a liability in urban operations, where engagement ranges can be 100-200m.
- Higher weapon elevation angles. If enemy positions are on roof-tops close to the RWS, then very high elevation angles are required to engage.

2.2.3 Integrated Operations

RWS introduce new capabilities that allow enhanced, integrated operations cutting across older roles.

RWS digital sensors are now superior to much standard surveillance equipment, allowing operational improvements with reduced resource requirements.

The firepower deployed with RWS allows the traditional cavalry role to be enhanced with more information drawn from more active engagements.

New RWS technology can deliver an integrated capability for detection, surveillance, monitoring, suppression, area denial, and focused firepower.

2.2.4 Weapon Flexibility

An unexpected limitation of current RWS is their ability to mount only a single weapon and its ammunition. In some situations, enemy combatants can exploit the limitations of the deployed weapon, once it is identified by them.

Emerging RWS mount dual weapons to provide operational flexibility and limit enemy countermeasures. These RWS also support new payloads such as non-lethal weapons, missiles or directed-energy weapons.

2.2.5 CT and CI Operations

RWS perform a key CT/CI function simply by protecting the gunner. This alone has reduced casualties from both IED and sniper attack.

RWS are applied in CT/CI operations in urban clutter, scanning for insurgents embedded in crowds, and counter-sniper operations. These roles are being enhanced with improved camera sensitivity and resolution, and embedded video and audio recording.

New technology in sniper detection and engagement has been integrated with most current RWS and sniper attack is now rare against properly equipped vehicles.

2.2.6 Counter IED Operations

RWS have assumed unexpected roles in counter IED operations, often through the innovation of users.

Depending on the elapsed time since concealment, new thermal imagers can detect turned earth potentially related to IED placement under the road. As other detection techniques emerge, these will probably be deployed on the RWS, since the RWS can provide a stable field of regard around the vehicle.

RWS accuracy is exploited for kinetic (ballistic) kill of exposed IED. Directed-energy IED kill systems which provide higher confidence in disabling IEDs are emerging as RWS payloads.

2.2.7 Training and Simulation

The rate of change of technology, capability and operational doctrine is accelerating, and emerging RWS include embedded training and simulation tools to accelerate effective operational uptake.

Embedded training and realistic simulation capabilities are vital if technology responses to new threats are to be fielded fast enough to be inside the battlespace of an adversary.

3. 2nd Generation RWS

3.1 A Paradigm Shift

There have been many innovations and improvements to RWS in the decade since the architecture of 1st Generation RWS evolved. Notwithstanding their imact, these improvements do not signal a fundamental change in RWS capabilitites, architecture or applicable doctrine. They do not mark the 2nd generation.

The paradigm shift that marks the next generation of RWS will be due to the parallel impact of:

- ***Wireless*** control of RWS;
- ***Autonomous*** operation; and
- ***Network***-capable RWS.

RWS with WAN capabilities will change the battlefield even more than 1st Generation RWS changed it since 1998.

3.2 Wireless Control

The ability to control RWS over secure wireless links will allow remote operation, at any distance. The deployment of RWS on remotely controlled vehicles will allow combat units to deploy without soldier-operators aboard or in close proximity.

In the near term doctrine will limit such deployments to close range, to be in close concert with manned operations.

However in the long term, as the technology becomes more established and confidence improves, very long range operations are conceivable. Based on past experience, this leap to long-range remote operations will occur very quickly if operational needs dictate.

3.3 Autonomous Operation

There is no near-term prospect of autonomous weapon systems that do not include a human operator in the firing loop. Current doctrine and common sense would not allow it.

However it is obvious that the effectiveness of a weapon system need not be limited by human responses to be completely safe. For example a target can be "authorised" for engagement by a human operator and then engaged by an autonomous weapon within 1-2 seconds without compromising operational safety or rules of engagement.

Autonomous RWS will likely include an operator "guiding" the weapon system by selecting the rules of engagement applying from time to time.

This concept allows the weapon system to respond to threats and to exploit opportunities much faster than any human could, but still within rules of engagement and firing parameters set in almost-real-time by a human operator.

Modelling confirms that autonomous RWS will out-perform manual variants.

3.4 Networks

1st generation RWS have already been networked together to provide multiple RWS controlled by a single operator. This is now achieved using a special configuration of software and cabling.

2nd generation RWS will take this a step further by having organic network-awareness and seamless connection-and-release from RWS networks.

At the network level the RWS can adopt a collective self-preservation attribute with enhanced situation awareness and mutually protective fields of fire.

3.5 Capabilities

The WAN attributes of 2nd generation RWS will give rise to a significant leap-ahead in performance.

The following missions and capabilities are already envisaged:

- Expanded options for less-lethal operations and precision engagement, with specific application in CT/CI operations. These operations leverage the collective intelligence of networked systems and full BMS integration.
- Simultaneous and high-precision engagement of multiple individual targets in strong blue-force clutter, using lethal or less-lethal force from multiple, dispersed weapons. Networking is essential for the required automated target allocation and hand-off.
- Long-range remote (quasi-robotic) operation of surveillance, reconnaissance and even close-in fire support operations.
- Networked weapon systems with interlocking, overlapping and mutually protective fields of fire.
- Highly reliable perimeter security with variable lethality and multi-spectral sensors fully networked.
- Total integration to BMS providing FCS capabilities from the ground up and direct access to resources such as navigation, comms, BFT (blue force trackers) and IFF (Identify Friend or Foe) systems.
- Removal of human operators and related protection and support provides unprecedented mobility and firepower combinations for next-gen remotely operated combat systems (ROCS).

- 2nd generation systems suitable as a disposable “leave-behind” rear guard to facilitate force extractions under fire.
- Collective situation awareness, constructed in real-time through wireless connections, will accelerate information aggregation to allow new tactics to be rapidly deployed for greater effect.

RWS with WAN capabilities are maturing and can be expected to deploy from around 2013.

4. Conclusions

1st Generation RWS have already evolved to provide enhanced roles and capablities not envisaged a decade ago. This is already providing major benefits to a wide range of operations.

2nd generation RWS will have an even larger and longer-term impact on future operations during the next decade and beyond.

- ➢ The RWS network itself will soon become the weapon, and the individual weapons, whether accompanied by soldier-operators or not, will assume lesser importance.
- ➢ Networking of sensors will provide compact, specific, coherent and relevant data to BMS data listeners.
- ➢ New paradigms for [e.g.] mobility and firepower may trigger major changes to operational concepts and doctrine.