National Audit Office

MINISTRY OF DEFENCE

Delivering digital tactical communications through the Bowman CIP programme

REPORT BY THE COMPTROLLER AND AUDITOR GENERAL | HC 1050 Session 2005-2006 | 25 July 2006

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Delivering digital tactical communications through the Bowman CIP programme

LONDON: The Stationery Office
£11.25

Ordered by the
House of Commons
to be printed on 20 July 2006

This report has been prepared under Section 6 of the National Audit Act 1983 for presentation to the House of Commons in accordance with Section 9 of the Act.

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19 July 2006

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1 The Bowman family of digital radios, and the associated Combat Infrastructure Platform, (CIP[1]) project, are central to the plans of the Ministry of Defence (the Department), to transform military communications and enable the Armed Forces to operate more effectively and at a higher tempo. The pressing need to replace the ageing analogue Clansman radios used since the 1970s and provide secure, reliable voice communications has made Bowman one of the Army's top priorities.

2 After the termination of the original Bowman procurement in 2000[2], the re-competed Bowman contract was won by General Dynamics UK in 2001. In 2002 General Dynamics UK also won the contract for CIP. Sensibly, given their close links and dependencies, the two projects have been managed by the Department and General Dynamics UK as one £2.4 billion programme, called Bowman CIP. Bowman's In Service Date was achieved in March 2004, though with 27 provisos, since reduced to 20. CIP did not meet its approved December 2004 In Service Date but in March 2006 it was declared in service with effect from December 2005, albeit with 32 provisos in addition to those for Bowman. Declaring an In Service Date as achieved subject to provisos is not unusual and is a way of making useful capabilities available to the Armed Forces as soon as possible. CIP equipment is integrated with Bowman and a limited CIP capability has been used with Bowman in Iraq since April 2005, where the equipment is bringing benefits to the Armed Forces. Notably, the secure voice radios and equipment showing the position of units have performed well and soldiers have growing confidence in them. Furthermore, the Department and General Dynamics UK have co-operated since 2003 to deliver Bowman enhancements under the Urgent Operational Requirements process, to provide the military communications capability needed to carry out specific operations in Iraq and Afghanistan.

3 We have found evident commitment to the success of the programme from a wide range of participants in the Department, the Armed Forces and General Dynamics UK. Yet delivering the Bowman CIP capability desired by the Armed Forces within specific time and cost parameters has proved difficult. Such parameters are based on the idea that a project reaches finality and essentially remains in a steady state until a mid-life update. But programmes like Bowman are in a state of continual development, as technical change and operational experience require continual adjustments to be made to them. **Figure 1 overleaf** highlights these factors as they affect Bowman CIP. Responding to the challenges set by these factors requires Bowman CIP to be managed as a programme where continual evolution and refreshment are the norm. Traditional, linear, approaches to equipment acquisition, with development, production and support activity punctuated by one or more mid-life upgrades, will not deliver the desired capability in a timely manner or to an acceptable cost. This report examines the lessons which can be learned from the experiences on the Bowman CIP programme which may also be applied more generally to better deliver and sustain other, similarly complex, military capabilities.

1 Combat Infrastructure Platform BISA, CIP, is described in Figure 3. It is a set of three interrelated projects with strong dependencies on Bowman that help with mission planning and dissemination of orders, provide additional hardware and information handling capacity and integrate these functions into armoured vehicles. It is intended to replace many existing manual military command and control processes.

2 By 1999, the Department had lost confidence that the Archer consortium could deliver a system that met its requirement in the necessary timescale and that offered value for money.

1 The challenge of delivering Bowman CIP

- The evolution of much of the technology underpinning Bowman CIP is being driven by rapid developments in civilian digital communications. Traditional, lengthy acquisition cycles are not well suited to respond to such rapidly evolving technological advances, adapting them to operations in the more hostile military environment or dealing with the obsolescence problems associated with long-term use of components with short life-spans.
- The ready availability on the civil market of mobile telephones offering not just voice communications but also text, pictures, video and ever faster links to the internet inevitably influences the expectations of military users.
- Bowman CIP is a crucial part of the Department's emerging vision for Network Enabled Capability. Bowman CIP must be managed in a sufficiently flexible way that it can respond to the changing demands likely to be placed on it as the Department's understanding of Network Enabled Capability evolves and as the other equipments which will contribute to its application are developed.[1]
- Delivering the full Bowman CIP capability has required the Department and General Dynamics UK to manage the delivery and installation of Bowman hardware while at the same time developing and trialling successive increments of the software intensive CIP project.
- Responding to constant feedback, from a wide community of Army, Navy, Royal Marine and Airborne users, as capabilities are delivered in increments.
- Installing sensitive modern electronic equipment into a diverse range in type and condition of vehicles up to thirty years old.
- Delivery of the Bowman CIP equipment and software is only part of the jigsaw of capability delivery. Its utility will be degraded if other aspects of capability such as training and support are not managed as a coherent whole.
- Delivering against this changing context within an exacting fixed cost ceiling, and to a demanding two and a half year timescale to meet the Departments' March 2004 target in service date for Bowman, and CIP.[2]

Source: National Audit Office

NOTES

1 Network Enabled Capability (NEC) offers decisive advantage through the timely provision and exploitation of information and intelligence to enable effective decision-making and agile actions. It involves joining up Defence systems in a "network of networks". A glossary of specialised terms is at the end of this report.

2 When General Dynamics UK was awarded the Bowman contract in 2001, the Departments' business case had concluded that the In Service Date should be maintained at the same date, March 2004, as had been set for the previous Archer consortium until 2000.

Management arrangements must be flexible and responsive and embrace all aspects of capability

4 The sheer scale and the demanding timescale of the Bowman CIP programme have severely tested many of the Department's regular management arrangements. The programme is not unique in this sense. As several of our recent reports have highlighted[3], the Department has not routinely supplemented its managerial and budgetary structures with a Senior Responsible Owner who is fully empowered with the authority to effectively manage a programme to deliver and sustain a given defence capability. Following the recent review of acquisition structures and processes in support of through life capability management ("Enabling Acquisiiton Change"), the Department is now moving towards more systematic use of Senior Responsible Owners for large equipment programmes. In the case of the Bowman CIP programme, in early 2006, recognising the need to improve higher level programme mangement, the Department took steps to establish a programme office to coordinate the delivery of the networks and the programmes supporting Network Enabled Capability, incorporating Bowman CIP.

5 The higher level programme management weaknesses contributed to shortcomings in the management of risks. Such risks have not consistently been well tracked and mitigated, and user requirements and expectations could have been better managed. The Department's processes for benefits realisation and tracking have also needed strengthening. There has been recent strengthening in both areas. Trials and ad hoc reports have given insights into how aspects of initial versions are performing. However, as only a limited capability has so far been delivered, it has not been possible to quantify how far the full system will bring the claimed measurable improvements in operational tempo and effectiveness. The Department intends to strengthen benefits realisation and tracking in taking the programme forward.

3 National Audit Office Reports: Ministry of Defence, *Building an air manoeuvre capability: The introduction of the Apache helicopter*, HC 1246 Session 2001-2002: 31 October 2002. *Combat Identification*, March 2006.

How the Department can further develop its managerial arrangements for the delivery and sustainment of military capability

The recent review of acquisition structures and processes recommended a number of changes to improve the cost effective and timely delivery and sustainment of military capability in the changing defence environment. Building on these changes:

a The role of Senior Responsible Owner requires both the authority that comes with senior rank and sufficient time to effectively discharge the onerous responsibilities. It would be unusual to find individuals in the Department with both. The Department should consider more regularly pairing a senior official with a full time programme manager leading a properly resourced programme office. This approach could be resource neutral if the Department re-allocates to the Programme Office tasks (and the resources at present being used to deliver them) which are being undertaken piecemeal by different parts of the Department or by its industry partners.

b The Department should increase the profile of benefits management on major programmes such as Bowman CIP to identify, optimise and track the expected benefits from the Business Case through to their realisation. A strong benefits management function generating robust evidence across all areas of a given capability should help programme managers to make better informed decisions in trading-off anticipated benefits against time and cost.

c All stakeholders, including suppliers, should have common access to information on risks and benefits tracking. Responsibility for the collation and analysis of data from all stakeholders, and co-ordination of subsequent actions, should rest with a programme manager.

d The Joint Systems and Networks Integration Bodies of Suppliers and Departmental officials, established in 2003 to link up Bowman CIP with complementary projects, are a step in the right direction. The Department should track their performance closely to understand how the principles can be applied to other defence programmes facing similar complex integration challenges that span multiple projects.

e In a long running programme such as Bowman CIP; measuring the continuing strength of the customer/supplier relationship, objectively and at regular intervals, will be particularly important.

Agile decision making must be underpinned by high quality information

6 Planning for and managing the delivery of new military capability is a hugely complex challenge. Successive Major Projects Reports have highlighted the adverse effects of the Department and its industry partners making key decisions, in cases where technical progress and operational experience require continual development and improvement of capability, without a robust understanding of technical maturity or realistic estimates of the costs and timescales.

7 By the time the Department had, sensibly, appointed General Dynamics UK as a single supplier to run both the Bowman and CIP projects as a coherent programme, it had already spent five years and £397 million (equivalent to 16.5 percent of the expected procurement cost of Bowman) on earlier stages, of which it subsequently wrote off some £51 million as not contributing to the later programme.[4] Despite this extended assessment phase, the Department's business case still understated the costs, timescales and technical challenges associated with delivering key elements of the Bowman CIP capability. The need for extra funding of £121 million has been identified, to overcome technical difficulties identified during the development of the Bowman system and for essential updates to take account of advancing technology.[5] Such changes are handled through amendment to the contractual Systems Requirement document. Though equating to only five percent of total equipment costs this is in the context of a reduced total number of vehicles and aircraft needing to be converted, and the deferral of less urgent, though important, capabilities to a possible later project. A trebling of the training facilities assessed as necessary to make full use of Bowman CIP in service will add a further £24 million of costs, and £204 million in total operating costs over 25 years. Robust system support costs are still being developed but are expected to rise beyond the levels forecast in the business case in 2001.

4 This was a combined cost of all the relevant work conducted with the previous Archer Consortium, and an extended Assessment Phase post Archer.
5 Paragraphs 4.6 to 4.7 illustrate the nature of the changes concerned.

8 The Department recognised from the outset that its aspiration to deliver the original capability within the approved timescale was ambitious. While there were clear cost and operational reasons which made it sensible to combine the fielding of Bowman and CIP in a single conversion, the rapid delivery of Bowman radios heightened the time pressure to develop and install CIP – a software-intensive programme requiring extensive trialling and development.[6] The Department and General Dynamics UK sought to mitigate this risk with a plan to install the hardware for both systems at the outset, followed by successive downloads of CIP software. But with too little time to trial, refine and retrial the equipment and software, and with the scale of the technical challenge becoming more evident, delivery of capability has slipped behind the original schedule.

9 Another and different kind of difficulty is that the Department and General Dynamics UK under-estimated the challenge of installing Bowman in the land vehicle fleet. In particular, not enough preparatory work was done by the Department or General Dynamics UK to underpin assumptions about how much variation there was within the approximately 20,000 vehicles in the fleet. Managing the conversion programme has been a difficult challenge for General Dynamics UK to resolve, for some of which they have borne the costs. Improved conversion rates, coupled with a reduction in the number of vehicles required to be converted, increase confidence that conversion can be completed by the end of 2007, within three months of the original schedule.

What more the Department can do to take well informed, agile decisions

In future, as complex capabilities are introduced and upgraded incrementally, making effective investment decisions on the delivery and sustainment of a given capability will place a premium on the ready availability of accurate, up to date management information. The Department is implementing initiatives to improve programme management and ownership in the Information Systems area.[7] Building on this work, and reflecting the experiences on the Bowman CIP programme, the Department should:

f Work with its industry partners to share and maintain full listings of programme assumptions as well as the rationale underpinning them.

g Consider further how to address the problem that advanced development programmes as complex as CIP bring inevitable uncertainty as to how they will be used. The greater use of limited mock ups or simulations for future Information and Communications systems (in particular showing how their human/computer interfaces will work), can help to plan for training needs. It can also help users understand how the system may actually be used in practice, including the implications for future tactical doctrine.

h Recognise more explicitly that the timely delivery of capability to the Armed Forces is always likely to include elements of programme concurrency, where a number of parallel activities must all be completed before a key stage can be passed. The Department needs to develop metrics to assess the extent of this in programmes. This should bring better informed judgements about whether programmes have enough risk margin and whether proposed timescales for the delivery of capability are realistic.

i Revise its definition of In-Service Dates so that progress on programmes planned to incrementally meet evolving capability needs can be monitored against appropriate "way-points" established when each increment of capability and the technology needed to deliver it can be defined with certainty.

j Maintain regular channels for contractors and end users to develop a shared, detailed, and regularly updated understanding of how new equipment will be used. Similar arrangements need to be built into procurement bidding processes, (which was not in General Dynamics UK's view sufficiently the case for Bowman CIP).

k Ensure statistically representative testing of the configuration and condition of existing vehicle fleets when planning major conversion programmes. The alternative given the complexity of the problem, is to achieve better configuration control of land vehicles.

6 The Brigade trialling Bowman was deployed to Iraq in 2005; trialling continued at a smaller scale using the Army's established trials organisation.
7 White Paper on Defence Industrial Strategy, Cm 6697 paragraphs C1.22–C1.24, December 2005.

The future of Bowman CIP

10 By December 2004, it was clear that the Bowman CIP programme was over-ambitious and needed thorough revision. A recast programme was approved in July 2006. The recast of the Bowman CIP programme has given the Department and General Dynamics UK greater confidence about the way ahead. Funding for the programme has been raised by £121 million (five per cent) and the timescale for delivering capability has been extended by two years to mid 2007[8] for full delivery of the minimum military capability required. Technical challenges remain to be overcome to secure and build on the operational benefits already being obtained through faster, secure voice transmission.

11 Beyond the capability to be delivered in 2007, the future of Bowman CIP will be heavily influenced by the outcome of a £10 million validation exercise to assess delivery of those high-risk, still-evolving capabilities which have now been deferred until they can be better understood. These include ensuring that the system is interoperable with other United Kingdom and allied countries' communication and information systems under the latest joint and NATO standards. The Department's best estimate to date of the possible cost of this modified, deferred capability, pending the outcome of the assessment exercise, is £200 million, but it emphasises that the estimate is highly uncertain given the extent of continuing and predicted change in the area of battlespace management projects. The decision to defer CIP capability to a later programme and to devote resources to understanding the risks and possible solutions was a prudent one to take in the circumstances.

8 Two years delay based on the level of capability envisaged in the Interim version of CIP planned for 2005 and broadly equivalent to the level of capability planned for CIP by 2007 under the recast programme.

PART ONE

Bowman CIP shows how complex programmes in changing environments require flexible and responsive acquisition

1.1 This part of the report shows how the previous history of the Bowman procurement, and the inherent complexity of the requirement when CIP was added in 2002, combined to make the programme challenging from the outset. And the requirement has evolved and been clarified over time against the background of rapidly changing communications in the civilian sector. Despite a difficult trialling and implementation phase due to the acute time pressure under which Bowman has entered service, the Armed Forces are now getting a new capability which the first units to use it consider has improved their combat effectiveness.

There was intense pressure to bring Bowman into service

1.2 The Clansman family of seven battlefield radios was designed in the 1960s and entered service during the 1970s with a planned 15 year life. **Figure 2** summarises the shortcomings of the Clansman radios. The importance of replacing Clansman with a secure communications capability has been championed by operational commanders and by the heads of army professions, such as the infantry and signallers, for the past 15 to 20 years. The need has also been confirmed by successive operational analyses undertaken since the mid 1990's and Bowman, the replacement for Clansman, has been widely described as one of the Army's top equipment priorities.

1.3 In addition to providing quicker and more reliable secure voice communications **(see Figure 3 overleaf)**, Bowman provides for:

- increasing the tempo of operations, by providing more immediate knowledge of the position and status of United Kingdom forces and by enabling faster planning and tactical decision-making;
- reducing risk of fratricide and casualties to United Kingdom and allied forces by delivering better, more up-to-date knowledge of the positions and status of our forces;

2 Problems with the Clansman family of radios

Most Clansman radios do not encrypt messages, meaning that soldiers normally must encode messages manually to maintain communications security. This takes time and reduces the tempo of operations.

Clansman is more vulnerable than Bowman to jamming and other forms of electronic warfare.[1] The radios were not designed for reliable communication within urban environments.

The radios use dated analogue rather than modern digital technology, and have a very limited capacity to carry data.

Spare parts have become more costly and difficult to procure due to component obsolescence. To make best use of resources, the Department is increasingly resorting to reuse and cannibalisation of radios from the first units converted to Bowman.

Source: National Audit Office

NOTE

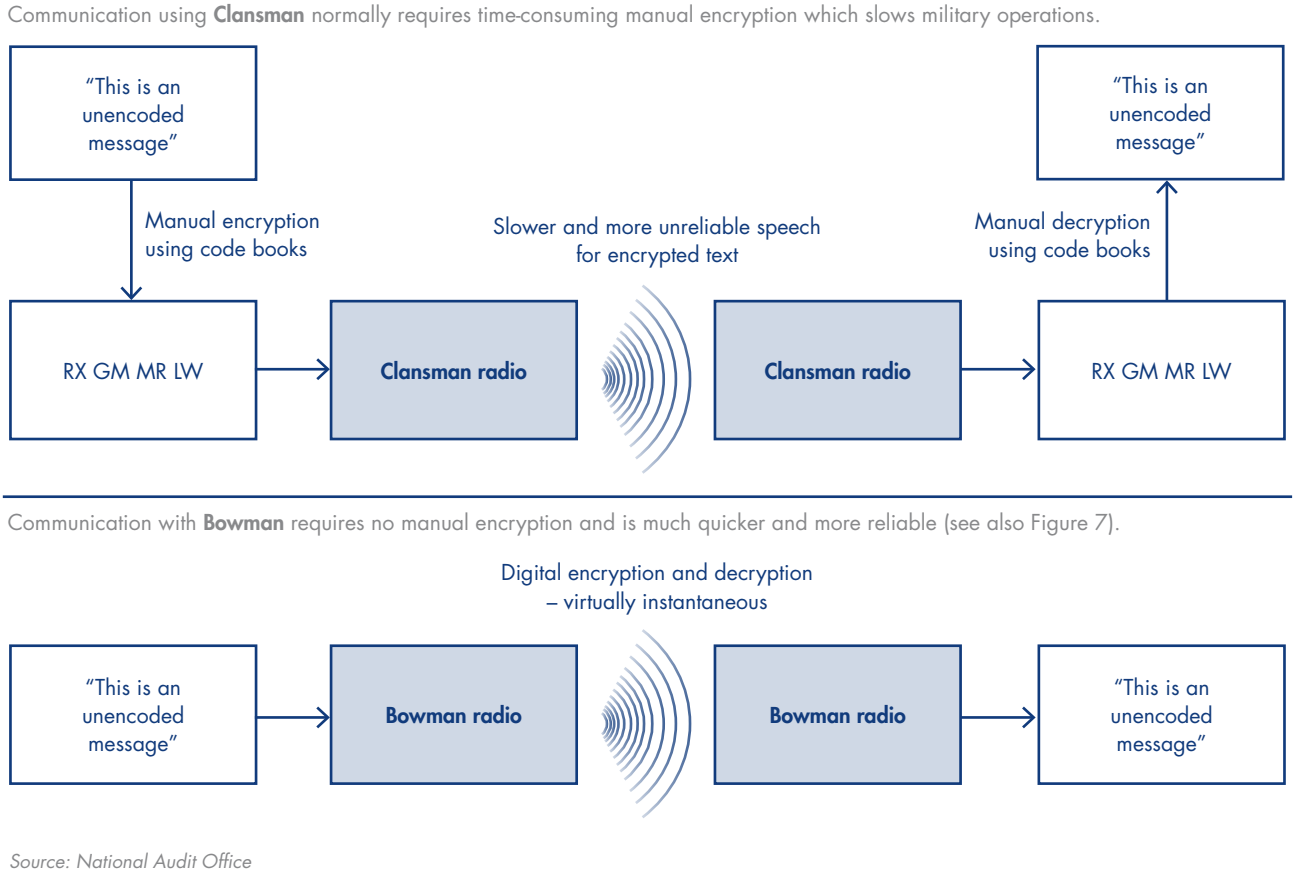
1 "... a 75 month delay in the Bowman project to replace Clansman meant the insecure Clansman system was used for tactical level communications, allowing Yugoslav/Serbian forces, the Kosovo Liberation Army and the media to listen in. Clansman is also unreliable – up to 35 per cent of 1 Para's Clansman radios required repair at any one time, many having to be sent back to the United Kingdom." Report by the Comptroller and Auditor General. Ministry of Defence *Kosovo: The Financial Management of Military Operations*, HC 530 Session 1999-2000.

- making better use of radio frequencies;
- providing a common radio system to be used by army units and those ships and aircraft which support land operations; and
- with more reliable performance, increasing the confidence that soldiers have in their communications.

Bowman has had a long and problematic history

1.4 As we and the Committee of Public Accounts have regularly reported, Bowman has had a long and problematic history.[9] The original In Service Date of December 1995, was set in 1988, well before the main investment decision point. The date was not achieved due to a mixture of technical and industrial difficulties and budgetary constraints. Between 1995 and 2000 the Department pursued a non-competitive solution with the Archer consortium,[10] with a forecast In Service Date which slipped progressively from March 2002 to March 2004. By 1999, the Department had lost confidence that the Archer consortium could deliver a system that met its requirement in the necessary timescale and that offered value for money. In July 2000, the Department launched a new competition and, in September 2001, appointed General Dynamics UK as Prime Contractor to deliver Bowman, maintaining the target In Service Date at March 2004. The speed with which the competition was conducted and the short, 30-month, period for the unchanged target In Service Date to be achieved, reflected the operational imperative to deliver a secure voice capability to the Armed Forces as quickly as possible. General Dynamics UK demonstrated commitment to meeting the Department's challenging target In Service Date by agreeing that a £5 million milestone payment would be conditional on that date being achieved.[11]

3 Compared to the previous Clansman radios, Bowman is providing quicker and more reliable secure communications



Source: National Audit Office

9 A chronology of events, including conclusions by the Committee of Public Accounts and the National Audit Office, is provided at Appendix 2.
10 Comprising BAE Systems, Racal and ITT.
11 In 2004 the Department declared this target to have been met, though with 27 provisos (paragraph 3.13), 20 of which remain extant and need to be resolved before the full required capability is delivered. The provisos, and progress towards removing them, are described in Appendix 5.

Bowman and CIP have proceeded in an environment of rapid and continuous change

1.5 The extended duration of the Bowman requirement, since its original conception in the 1980s, has added to the difficulty in managing the expectations of end users. Military personnel have observed rapid developments in civilian digital technology over this period, as mobile telephony has been enhanced to offer text, pictures, video and links to the internet. Understandably, military users have come to expect comparable functionality from Bowman, particularly in terms of communications of data as opposed to voice. For example, the 1999 Bowman Performance Specification defined the required capability for 95 per cent of all data exchanges as up to 128 characters. While most data transmissions would still be in that range, today a few, larger messages require the capability to handle up to 500 thousand characters.

1.6 Keeping pace with civilian communication developments brings additional difficulties in a military context. Whereas civilian internet networks operate through a fixed infrastructure in a benign environment, the form of military "tactical internet" now envisaged for Bowman has to carry its own portable infrastructure as its Users move around the battlespace. It also needs to be able to operate securely in a hostile electronic environment.

1.7 In 2002 the Department took the opportunity to add further advanced capabilities to the original Bowman requirement. By the late 1990's the Department was developing early versions of the concept of Network Enabled Capability, to harness developments in information processing, digital communication and networking capability. Whilst the Bowman radio network could provide much of the underlying infrastructure to support a new, mobile, "tactical internet"; an additional suite of applications was needed to replace the existing, manual, battlefield command and control mechanisms to achieve the desired improvements in military effectiveness. To deliver these additional applications the Department established the Combat, Infrastructure and Platform BISA (CIP) project. The three key elements of CIP are described in **Figure 4, and Figure 5 overleaf**.

4 The Combat, Infrastructure and Platform BISA (CIP)

ComBAT "screenshot"

CIP is three interrelated projects procured as a single entity to replace current manual mechanisms for command and control on the battlefield.

1 **The Common Battlefield Applications Toolset, (ComBAT):** is to provide the core of the battle management system, from fighting vehicles up to divisional headquarters. Integrated into Bowman its role is to support command and control, as well as provide situational awareness, of military units. The purpose is to quicken the tempo of operations, and assist the survivability and effectiveness of land forces.

2 **The Digitisation Battlespace Land Infrastructure:** is to provide the software to enable ComBAT and other Battlefield Information Systems on Bowman to operate concurrently. It also intended to deliver computer terminals, ancillary devices and office automation into field headquarters, enable best use of information and enable collaboration with allies, through interoperability with their systems.

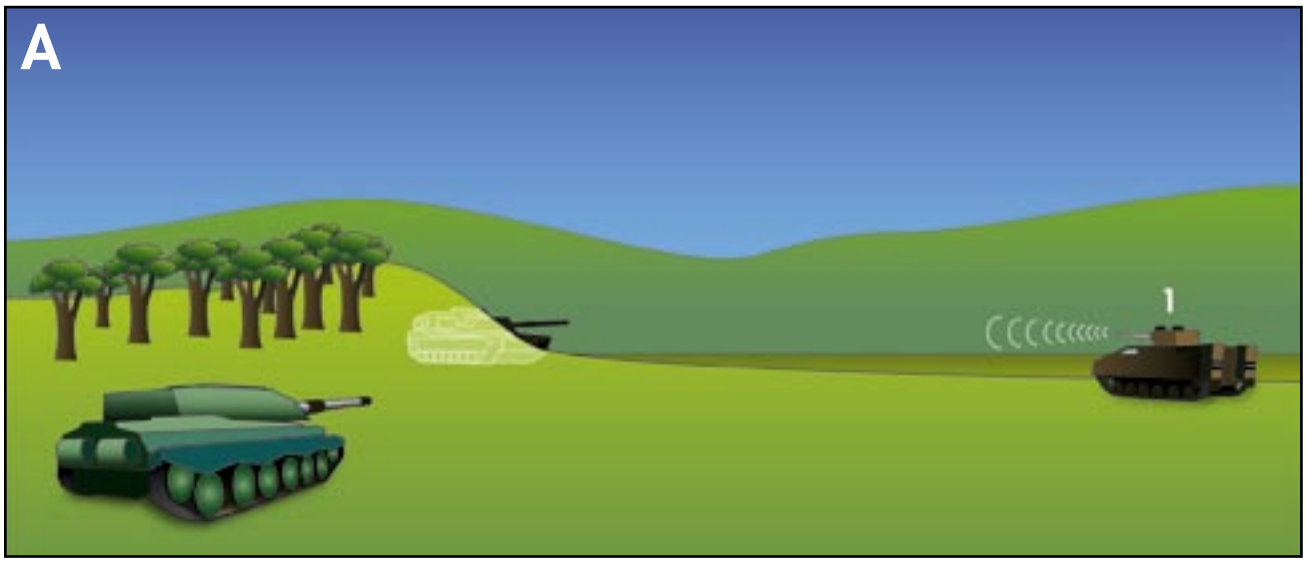
3 **The Platform Battlefield Information System Application (P-BISA):** is to integrate ComBAT and the infrastructure software, together with existing and planned systems and sensors, into armoured fighting vehicles, such as the Challenger 2 main battle tank, to optimise their fighting capability.

An example of how this can work on the battlefield is shown overleaf in Figure 5.

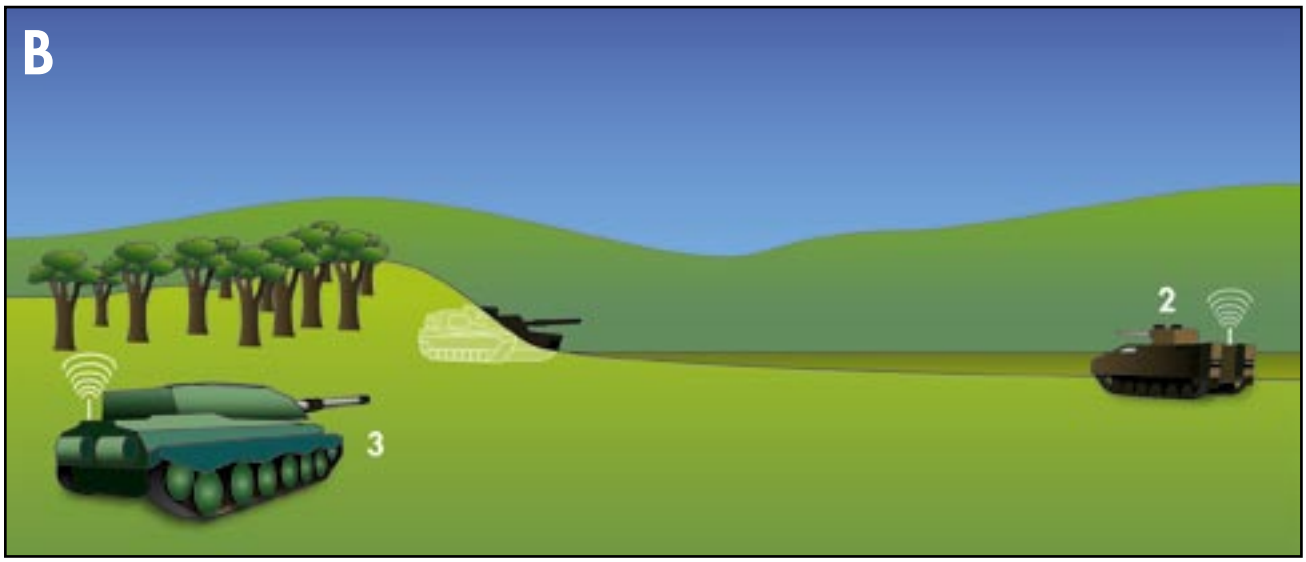
Source: Ministry of Defence

5 An operational example of use of CIP to link weapon systems

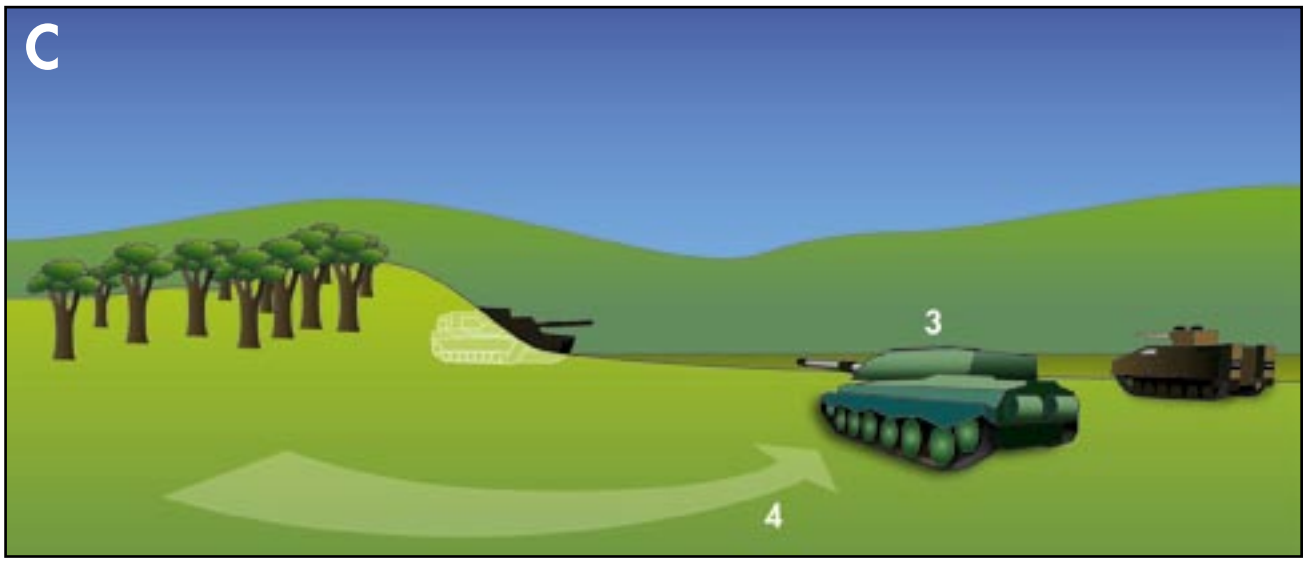
Case Study



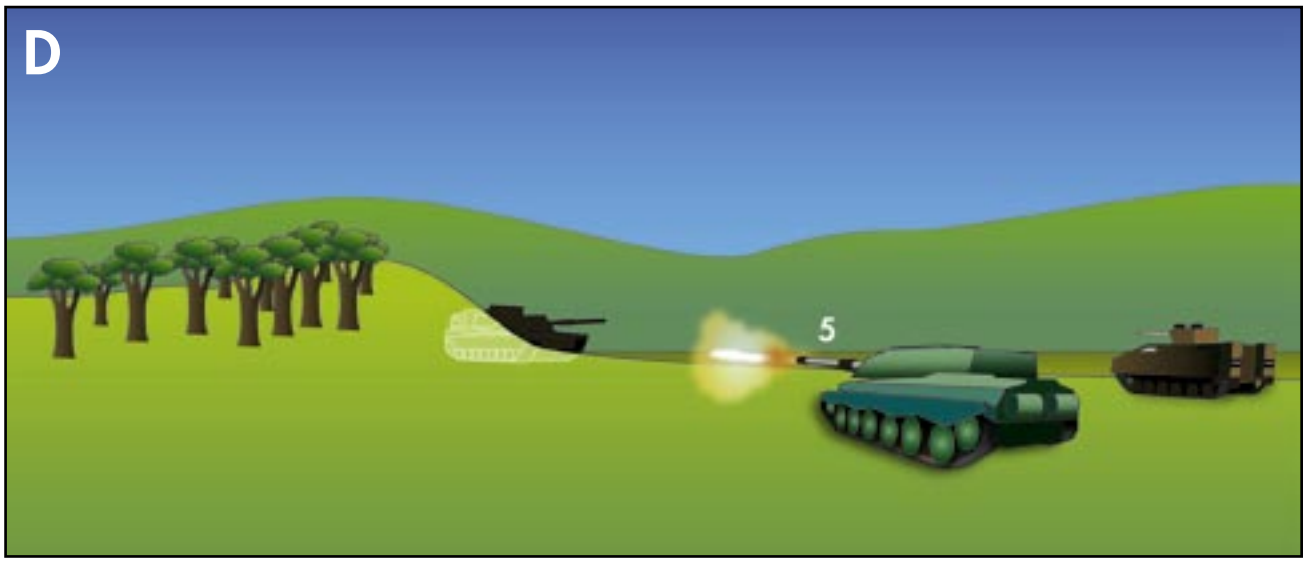
1 Imager on Warrior vehicle sights target  Imager passes target coordinate to Bowman 



2 Bowman passes information to tank via radio. Bowman passes information to tank gun control 



3 Gun control points gun as **4** tank moves to engage target



5 Tank engages target

1.8 Given the operational imperative to deliver secure voice communications capability and the relatively immature state of the CIP requirement, the Department chose not to invite bids for the Bowman and CIP projects as a single programme. Rather, it ran a separate competition for CIP, after General Dynamics UK had been contracted to deliver Bowman. General Dynamics UK won the CIP competition and, in December 2002, were contracted to deliver the project, with an approved In Service Date of December 2004, (although meeting this date was not a contract deliverable). In October 2005 the Department and General Dynamics UK reached agreement in principle to a recast programme for Bowman and CIP with an increased cost and timescale, recognising the difficulties they had encountered and that the technical solutions, as expressed in system requirements, needed to meet users' requirements had evolved in the intervening four years, (paragraphs 4.6 – 4.7).

1.9 The Department and General Dynamics UK had recognised the need to be able to respond to evolving end user expectations, particularly as initial trials showed how the equipment needed to be refined and developed to best meet users' needs. So they planned the development and roll-out of CIP to allow for successive planned upgrades in its capability between 2004 and 2007, and the Department instituted a change control system to minimise the rate of unplanned changes. During the life of the programme, system requirements have been changed in response to evolving technology to deliver more effective technical solutions.

Bowman CIP is improving operational effectiveness within the Armed Forces

1.10 Military Commanders made the decision to deploy Bowman and a limited CIP capability to Iraq in April 2005, following Operational Field Trials in late 2004 which showed that the benefits of the available capability outweighed the downsides of deploying a system that was still in development and was not installed on all types of vehicles, **(Figure 6)**. This confidence has been borne out by the experience of 12 Mechanised Brigade in Iraq and through trials at the Army's training facility in Canada. **Figure 7** shows how the initial capability deployed has already improved operational effectiveness within the Armed Forces.

6 Initial deployments of Bowman CIP on operations in Iraq have been incomplete

Key capability	Status of service in Iraq
Secure voice transmission, often over greater ranges	In service
Users able to determine their own geographical position	In service
Commanders able to determine position of their units	In service, but initially not on all vehicles
Ability to transmit data	Very limited capability at this stage
Ability to handle large quantities of data in headquarters	Very limited capability at this stage
Ability of system managers to manage the network effectively	Very limited capability at this stage
Ability to interchange data with other nations' forces and with other United Kingdom communications systems.	Very limited capability at this stage

Source: National Audit Office

7 How incomplete versions of Bowman/CIP have improved operational capability within the Armed Forces

Area of improvement	Examples
Secure communications are making it easier and quicker to pass information	The British Army Training Unit in Canada has stated that the availability of secure speech across the BattleGroup has increased the tempo of battle, with Situation Reports being submitted some 20 per cent faster than with Clansman. *"Last night it took me 15 minutes to issue our orders talking in clear, uncoded speech.... Using BatCo that message would have taken one hour to broadcast and another hour to code."* - The Commanding Officer of 1st battalion Royal Regiment of Fusiliers in Iraq.
Force protection and operational tempo are improving	In Iraq, 12 Brigade logistic re-supply convoys have been tracked successfully. For example, commanders were able to direct a convoy's movements in the knowledge of risks ahead of it.
Long distance communications capability is better	The High Frequency radio has demonstrated that it can operate over greater ranges with greater reliability than the Clansman radio. This has been vital in Iraq where troops are more dispersed than in conventional war-fighting. Reports from troops in Iraq state that Bowman secure voice and Situational Awareness are having a direct and positive effect on the communications capability in theatre.
User confidence in the equipment is increasing	Past military experience shows that as soldiers get used to new equipment and become more confident about its capabilities, they will try to use it in new ways, further increasing functionality. Commanders appear enthusiastic about the potential to use "real-time" information on the geographical location of their units.

Source: National Audit Office, and Army Reports

PART TWO

Bowman CIP demonstrates the need for programme management arrangements that can cope with complexity and change

2.1 This part of the report shows how the sheer scale of the Bowman CIP programme, reaching across the Armed Forces and interfacing with a wide range of legacy and future equipment, has posed a severe challenge to the Department's management arrangements. A part of the difficulty has been that the Department's procedures are evolving from a position where systems were developed and delivered within a single discrete timeframe, rather than those like Bowman CIP that are developmental in nature and delivered in increments.

2.2 **Figure 8 overleaf** illustrates the large scale of the combined Bowman CIP programme. The installation of Bowman CIP across the land vehicle fleet is regarded by the Army as equivalent to the commitment required for a medium scale military operation.[12] And it also involves conversion of ships and aircraft.

2.3 The Bowman solution proposed by General Dynamics UK further develops the IRIS secure radio communication system, already acquired by the Canadian Armed Forces, to include advanced situational awareness and mission planning functions. As was recommended by the Department, the system also utilises much of the work undertaken by the Archer consortium under earlier work terminated in 2000. Nevertheless, both the Department and General Dynamics UK recognised that fully developing and integrating the technologies, including some of the pre-existing radio equipments which still carried risks to their performance, all whilst under pressure to deliver Bowman to a tight timescale, would be a difficult challenge. At the time the Bowman and CIP contracts were let there was still uncertainty associated with the performance of key technical components, such as the advanced High Capacity Data Radio which transmits most data for CIP and needed to be further developed to ensure robust and resilient communications as users moved around the battlefield.[13]

12 Depending on the nature of the operation, a medium scale operation on Land is defined as approximately brigade-sized (some 3,500 to 5,000 personnel).
13 The requirement to deliver the High Capacity Data Radio was always at the forefront of technology, as recognised in trials undertaken in 1996-97. When the contract was let to General Dynamics in 2001, this risk had been reduced but was accepted as still a key risk.

8 Bowman CIP is a huge and Complex programme

Conversion	Taking place in the United Kingdom, Germany and Canada.
Combat formations	Seven army brigades and 3 Commando Brigade to be converted from 2004 to 2007.
Land vehicles	Up to 15,700 vehicles, from Land Rovers to Challenger 2 main battle tanks.
Naval platforms	Some 141 vessels, from the ships as large as Assault Ships down to rigid inflatables.
Aircraft	Some 60 Chinook and Merlin helicopters, and links to the Apache attack helicopter using Bowman installations in land vehicles.
Radios and computers	Around 48,000 radios (as well as the 45,000 small Personal Role Radios procured separately but integrated into the Bowman programme) and 26,000 computer terminals.
Training	75,000 Service personnel to be trained in the United Kingdom, Germany and bases around the world. There are some 55 static Bowman platforms, mainly at training sites

Source: National Audit Office

Programme management arrangements require enhancement

2.4 **Figure 9** shows the complex inter-relationships between the main stakeholders in the Department, the Armed Forces and industry. The officer who led the Integrated Project Team for Bowman CIP until 2004 considers that addressing the expectations of this very large and diverse stakeholder community was the most difficult aspect of the programme for his team during his tenure. Other large Defence equipment programmes face similar challenges.

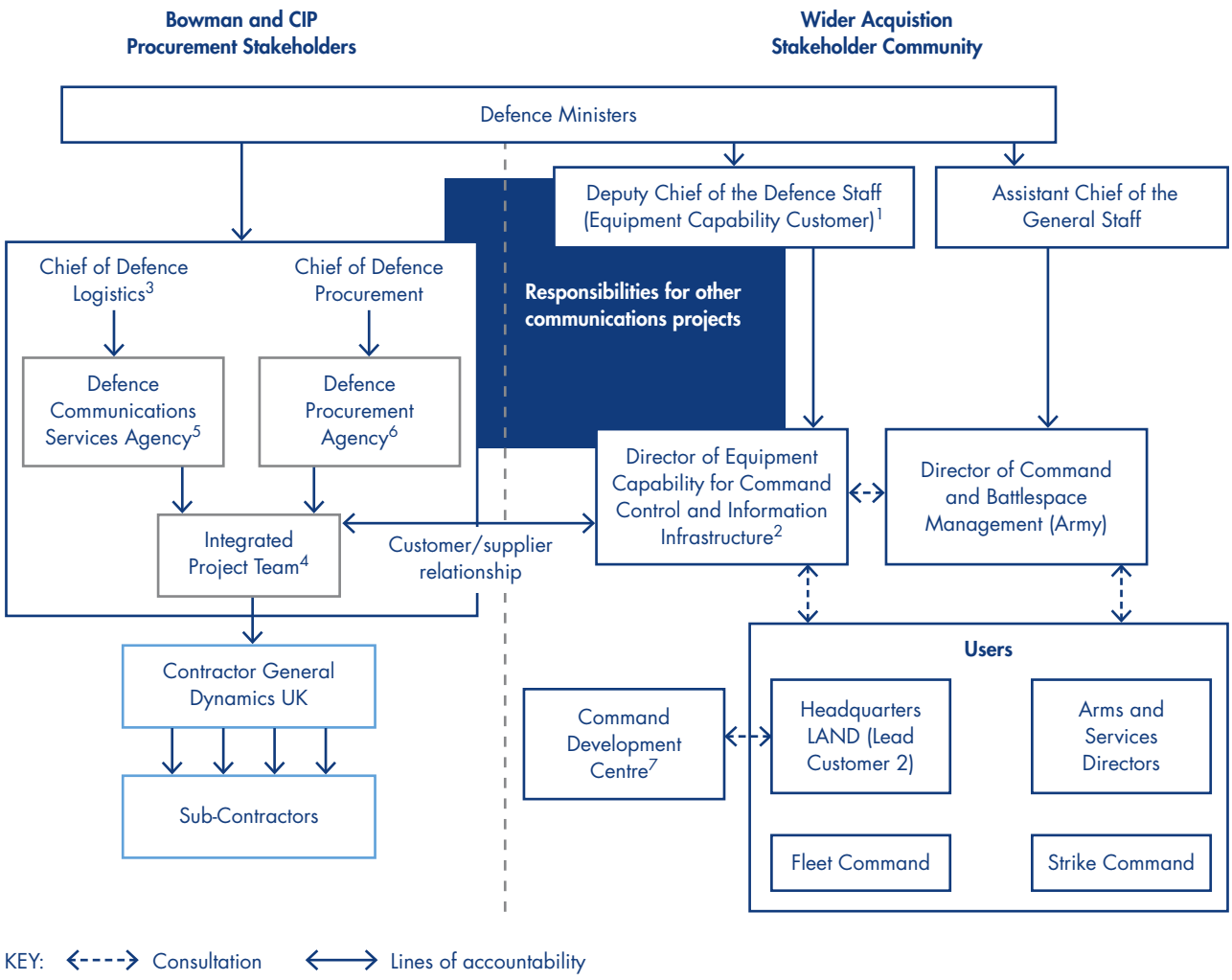
2.5 The governance arrangements have evolved over the period since the contract was awarded. In February 2002, the Department had appointed the Assistant Chief of the General Staff as "the focus for oversight of the introduction of Bowman." This recognised his existing role as a Core Leader providing overall strategic management for the Army and reinforced customer involvement in the acquisition process. Principally through quarterly steering groups, he has received briefings on equipment and non-equipment issues from key stakeholders.

2.6 In 2003, after the inception of the Bowman CIP programme, the Office of Government Commerce[14] emphasised a number of key features of good programme management to ensure the co-ordination of projects and their interdependencies in the pursuit of agreed goals. A key aspect of its guidance is the appointment of a Senior Responsible Owner (SRO) who is ultimately accountable for the success of the programme and responsible for enabling the organisation to exploit the new environment resulting from the programme, meeting the new business needs and delivering new capabilities. The Office of Government Commerce also advised establishing a Programme Office to ensure that the programme is proceeding coherently.

2.7 Since 2003, the relevant Director of Equipment Capability has been accountable for ensuring the delivery of new military capability, across equipment and non-equipment lines of development. Following the recent review of organisation, structures and processes in support of through life capability management ("Enabling Acquisition Change"), the Department is now moving towards more systematic use of Senior Responsible Owners for large equipment programmes, located within the central equipment capability customer. In particular, it has recently appointed (paragraph 2.9 below), in the Equipment Capability Customer organisation, a senior officer who is in effect SRO for the networks and systems supporting Network Enabled Capability, including Bowman CIP. The Department has also begun to establish programme offices to oversee some of its largest business change initiatives and major equipment programmes, including a programme office to coordinate the delivery of the networks and programmes such as Bowman CIP which support Network Enabled Capability (paragraph 2.9 below).

14 *Managing Successful Programmes*, Office of Government Commerce, 2003.

9 There are many stakeholders with an interest in the Bowman CIP programme



Source: National Audit Office

NOTES

1 The Equipment Capability Customer acts as the central customer (Customer 1) for the acquisition of new military capability. Its role is to assess and prioritise requirements and construct a balanced and affordable Equipment Plan that meets them.

2 Director of Equipment Capability for Command Control and Information Infrastructure: is one of the Department's Directors of Equipment Capability. DECs are accountable for ensuring the delivery of new military capability within performance, integration, cost and time parameters, and across equipment and non-equipment Lines of Development.

3 Defence Logistics Organisation: Provides and directs logistics support to the Armed Forces.

4 Integrated Project Team: Manages projects from Concept to Disposal. Its main tasks include devising equipment solutions to meet requirements, and managing the procurement and in-service support of the equipment. The Bowman and Tactical Communications & Information Systems (BATCIS) IPT is also responsible for other programmes in the military communications area. It is dually accountable to the Chief of Defence Procurement and the Chief of Defence Logistics via the Defence Communications Services Agency.

5 Defence Communications Services Agency: Separate from the DLO, but owned by the Chief of Defence Logistics, provides and assures Defence end-to-end communications, infrastructure and applications.

6 Defence Procurement Agency: is responsible for the procurement of equipment for the Armed Forces.

7 Command Development Centre: Develops Command and Control and Command Support capability for Land Component operations, in the context of Joint and Multinational forces.

2.8 Although no Senior Responsible Owner has been appointed for the Bowman CIP Programme, many stakeholders came to assume that the Assistant Chief of the General Staff had taken on that role, (paragraph 2.5). He has neither funding nor managerial authority for the Bowman CIP programme. He exerts influence, in support of the Equipment Capability Customer, (Figure 9), to persuade stakeholders to resolve issues associated with the programme. Users' concerns have generally been raised in working groups, which in the context of Bowman has required many stakeholders trying to resolve very long lists of issues. The Assistant Chief also has many other important responsibilities that prevent him from devoting extensive time to any single equipment programme. He has been supported by a Directorate which acts as the focal point for Land Command and Battlespace issues, and which provides support on non-equipment aspects such as training, and concepts of how the system will be used. The Directorate does not have direct budgetary responsibilities, nor is it resourced to act as a programme office.

2.9 Programme governance is complicated by the fact that Bowman CIP is just one programme alongside others that together contribute to the Department's vision for Network Enabled Capability; a "Network of Networks". So work to prioritise different demands across the Armed Forces has had to address dependencies between Bowman CIP and other programmes, as well as within Bowman CIP itself, to enable a coherent view to be presented to the Integrated Project Team responsible for delivering the equipment-related elements of the programme. The Department has made a Senior Officer in the Equipment Capability Customer Area (Figure 9) responsible for the delivery of the network of networks, (and the systems sitting upon it), that will underpin Network Enabled Capability and for dealing with the integration risk inherent in delivering military capability in this area. Thus senior level oversight has been provided for the programmes that contribute to the network of networks, of which Bowman CIP is a key element. And, to further improve governance, in early 2006 the Department took steps to establish in the same Customer area, a programme office to co-ordinate the delivery of the networks and programmes supporting Network Enabled Capability, again with Bowman CIP as a key element.

Risk management arrangements have needed improvement

2.10 The elements of the programme that were inherently low and medium risk, for secure voice and basic situational awareness, are being delivered. But risks to more technically difficult elements, for transmitting and handling data, have had a real impact on delivery. Though the Department generally identified these risks, it has lacked some of the programme level arrangements to help it effectively manage them. The main underlying problems were:

- though various risk registers were maintained by stakeholders throughout the Department, there was not initially an actively managed strategic risk register, suitable for use by a Senior Responsible Owner at Programme level, encompassing risks across equipment and non-equipment lines of development. Such a risk register shared between the Department and General Dynamics UK would have enabled them to understand and respond better to each others' concerns. In the absence of a Programme Office to do this, the current directorate supporting the Assistant Chief of the General Staff made an effort to compile such a register in 2005. This is to be undertaken in future by the new programme office coordinating the delivery of networks and programmes for Network Enabled Capability;
- within the Department's risk registers, unclear allocation of risks to specific individuals, a lack of clarity on the success of mitigation actions, and an emphasis on minimising damage from risks rather than prevention;
- limited arrangements at the outset to manage Bowman CIP inter-dependencies with other projects and programmes in the Network Enabled Capability arena, such as other communications and weapon systems being developed;
- a general lack of programme-level fall-back or contingency options in the event of failure of key elements of the programme; and
- initial over-optimism about the ability of suppliers to mature the design of a complex new network technology, while in parallel developing and integrating new battlefield systems to use it.

End user requirements and expectations could have been better managed

2.11 At the highest level the Department defined its overall performance requirements for Bowman and CIP in terms of 30 high level Key User Requirements (listed at Appendix 3), supported by more numerous detailed requirements. The Major Projects Report 2005 records that the Department expects to meet all of these requirements, although it assessed one, the provision of a secure and robust tactical internet, to be at risk. The Department is satisfied that the recast programme, if successful, should fulfil all of the key user requirements. However, risks against fulfilment of up to nine of the key user requirements will require careful management in the coming year. The most challenging areas are assessed in paragraphs 4.10-4.17 below.

2.12 Beneath these high level statements, the Department's guidance recommends the use of requirements management tools to track and manage changes in detailed system requirements. The Integrated Project Team established and used such a system from the outset. The main weakness in requirements management has been the lack of constant attention, under the pressure of time and competing priorities, to managing the large number of stakeholders and the expectations of users. The rising expectations of multiple users, against a background of rapid developments in civilian communications and emerging operational needs, led to uncertainty about how detailed system requirements should be prioritised when such requirements potentially conflicted. At the detailed technical level there have been some 300 change requests from the Department to General Dynamics UK, and some two thousand concessions granted to the company by the Department.

2.13 Problems with the development of the radio designed for use by, among others, infantry sections in dismounted close combat, described in more detail in Appendix 4, illustrate the issues. In order to deliver greater functionality and meet more exacting performance requirements in a range of uses, for example in terms of security and positional reporting, the radio and its batteries together weigh slightly more than the Clansman radio it is replacing. Together with size and ergonomic issues this potentially impairs the mobility and combat performance of dismounted combat troops. Successive Directors of Infantry have stated since the late 1990s that increased weight and size are unacceptable. The Integrated Project Team did not obtain Director Infantry's acceptance of its size, ergonomic and weight characteristics. Though the radio met the requirements of other users, its development continued for several years, against a background of ongoing dialogue, on the basis of a de facto "agreement to disagree" over its suitability for use in close combat by dismounted infantry. The Department has agreed that General Dynamics UK has supplied what it was asked to in the contractual system requirements document, and is now examining alternative ways of meeting the specific needs of dismounted troops, (Appendix 4).[15]

2.14 Resolving emerging issues with General Dynamics UK has also been adversely affected by the relative immaturity of the definition of detailed system requirements when the Department re-competed the Bowman requirement in 2000. This was a brisk process and in General Dynamics UK's view, bidders were not able to spend the time with military units that would have given them a deeper understanding of how the Armed Forces would use Bowman CIP and would have enabled them to have offered better designed proposals.

2.15 In early 2005, as part of the process of reviewing the programme and of seeking approval for a recast programme, the Integrated Project Team took stock of the remaining requirements, in conjunction with other stakeholders. The outcome of this review is described in Part 4.

15 General Dynamics UK inherited this radio from the earlier Archer procurement.

Benefits realisation and tracking is in its early stages

2.16 The key new capabilities are secure voice, interoperability and situational awareness, and the operational benefits are derived from these. It is difficult to attribute military benefits with precision to Bowman CIP, because improved operational outcomes on the battlefield depend on many factors besides equipment. However, when the Bowman and CIP programmes were approved, the decision was predicated on the achievement of significant quantifiable operational benefits, summarised in **Figure 10**. We examined the operational analyses, undertaken between 1996 and 2001, that underpin the projected benefits and found they were conducted in accordance with best practice at that time.

2.17 Since the project was approved it has only been possible to conduct limited, formal, tracking of the achievement of the expected operational benefits. This is because the initial system fielded has so far been too new and incomplete to determine the overall effect in terms of increased tempo, reduced fratricide or other quantified measures of military effectiveness. Reports are being submitted by initial users, but it will not be until the next major increment of the system, BCIP 5 in 2007, that there will be a clear linkage between the benefits projected in the Operational Analysis, the contractual Key User Requirements for the system being procured, and the targets set in Departmental Plans. Only then will there be a consistent and formal benefits realisation process.

2.18 Given the limited opportunity to track the benefits of the whole system, we asked early Users of Bowman CIP in 12 Brigade whether in their experience, the benefits claimed in the business case appeared achievable. Their overall conclusion was that they recognised the great potential of the system and that benefits on this scale could be credible, but that much more work needed to be done and difficulties overcome before they were within reach. Such assessments from Operation Telic in Iraq are being incorporated into a formal audit which is looking at benefits from a range of projects delivering Network Enabled Capability.

10 Projected operational benefits for a Bowman CIP capability

The Army and the Defence Evaluation and Research Agency ran a range of trials and simulations in the late 1990s to predict the benefits of the main components of Bowman CIP. A faster battle tempo, meaning that decisions are taken and acted upon more quickly, is a key factor in successful military operations.

1 Simulations conducted at the Simulation Networking facility in Germany in 1997 indicated possible gains from a basic Battle Management System that would:

- significantly reduce own force casualties by 25 per cent;
- reduce the time for the planning phase of military tasks by up to 40 per cent; and
- increase battle tempo by approximately 35 per cent.

2 Live trials and simulation[1] at the British Army Training Unit, Canada, in 1998, showed that the secure voice communications and position awareness (the core Bowman capabilities) could:

- improve battle tempo, through increasing the tempo of command and control decisions by at least 35 per cent; and
- reduce fratricide by 50 per cent through increased awareness of location of own forces. [For example, there is a higher risk of fratricide when fast-moving own forces occupy locations previously held by the enemy]

3 Operational Analysis through modelling and simulations in 1999 indicated that:

- each Bowman component significantly enhanced operational effectiveness (projected mission success) in four military scenarios;
- an interim CIP-type system would increase battle tempo by approximately 65 per cent and reduce casualties by approximately 25 per cent; and
- provision of an enhanced CIP-type system with additional capability to carry data would increase battle tempo by 75 per cent and reduce casualties by 45 per cent.

Source: National Audit Office

NOTE

1 Through simulation of secure voice using Clansman, without the use of manual messaging encoding, as if it were a secure voice system.

PART THREE

The programme illustrates how decisions to proceed require sufficient understanding of the time and resource required to deliver the capability

3.1 Many of the difficulties encountered by the Bowman CIP programme arose because at the time of the programme Business Cases in 2001 and 2002 the Department underestimated the technical challenges, and hence the resources and time that would be required to deliver and support this sophisticated new capability. The timescale proved too aggressive because there was not enough risk margin in the programme to allow the Contractor and Department to respond to early lessons before large scale conversion of units and vehicles began. And the level of resource required was underestimated in four main areas:

- the costs of developing and producing the equipment;
- provision for technical support and ongoing training of users on Bowman CIP once the system is in service;
- the systems integration effort that would be required to link up Bowman CIP with other defence information and communication systems; and
- the effort required to convert the Army's disparate vehicle fleet to Bowman.

Difficulties have arisen because of the aggressive timescale

3.2 Given the operational imperative to deliver as quickly as possible the secure voice capabilities of Bowman, the Department planned for, and General Dynamics UK contracted to deliver, Bowman CIP to a challenging timescale.

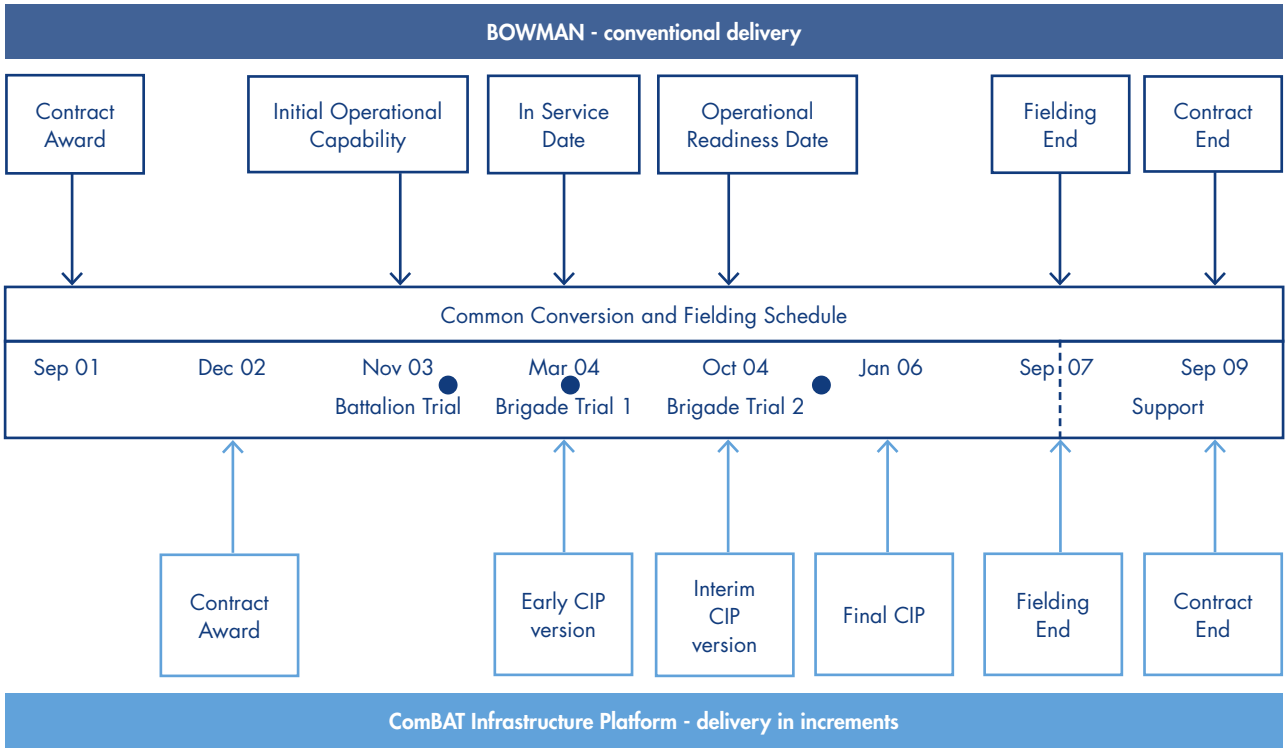
There was an integrated programme to field Bowman and CIP

3.3 By appointing General Dynamics UK to manage both projects as a single integrated programme, the Department minimised the risk of disputes about interface problems, interdependencies and the flow of information between separate suppliers and the Department, which have caused problems on a number of other projects.[16] Appointing General Dynamics UK to manage both projects also meant that units could more easily be converted for Bowman and CIP at the same time, and their vehicles taken out of service just once. This was particularly important given the heavy operational and training commitments facing the eight army and commando brigades to be converted. There were, however, tensions between the planned single Bowman CIP conversion programme and the more extended development and trialling required for CIP. The Department and General Dynamics UK both recognised from the outset that it would not be possible to fully develop all the CIP software and hardware, or to design and embody the modifications which were bound to come from early user trials of the new capability, by the start of vehicle conversion in late 2003. As **Figure 11 overleaf** shows, CIP was therefore planned to be developed and installed in three increments aligned to the Bowman delivery schedule. Against this plan, delivering even the initial version of CIP was dependent on there being a stable and mature Bowman data radio system to underpin it.

16 For example, see Ministry of Defence, *Building an air manoeuvre capability: The introduction of the Apache helicopter*, HC 1246, Session 2001-2002: 31 October 2002.

11 The original programme allowed for CIP to be developed in increments after Bowman

The aligned Bowman CIP Programme



Source: General Dynamics UK and National Audit Office

NOTES

The In Service milestone for Bowman is defined as a Brigade Headquarters, two mechanized battalions and support troops capable of engaging in Operations Other Than War, such as peace support.

The Main Gate approval recognised that CIP would be fielded in successive software updates between 2004 and 2006 to manage the inherent risks attached to the fielding of a large and complex programme in a single stage. Although the approved In Service Date for CIP was December 2004, a demanding target of March 2004 was set to introduce the initial capability increment coincident with the delivery of Bowman.

High concurrency in the programme has led to problems

3.4 The considerable overlap between hardware and software development, trialling and production meant that it was difficult to learn in good time from the experiences of the Army's lead units for Bowman in 2003-04, (first the Royal Anglian Regiment, then 12 Mechanised Brigade), and from early difficulties with the conversion of vehicles (paragraphs 3.16 to 3.18 below). For example, while 12 Brigade's Warrior armoured vehicles were being converted, it emerged that new night vision equipment caused interference to Bowman radios. A further multifaceted problem emerged that for example intermittently prevented the Warrior Commander from speaking with the driver via the existing analogue headset. Though solutions to these problems were found, there was insufficient time in the programme to implement them before 12 Brigade's deployment to Iraq. As a result the Brigade's armoured vehicles deployed without Bowman, and also without a thermal imaging capability for night vision, which could not be installed until the problems were resolved.[17] The brigade's vehicles are now being retrofitted and most units subsequently deployed to Iraq will have this capability. This is an example of how expensive integration can be: the Department met 80 per cent of the £5 million cost of rectifying the problem; General Dynamics UK the rest.

17 Co-ordinating the installation of Bowman and the Thermal Imaging system within the limited space inside armoured vehicles offered benefits of efficiency and effectiveness.

3.5 Because of the lack of available time in the programme to accommodate later than expected delivery of hardware, not all equipment was tested in extreme climates. For example, a key system component for handling data, the Personal User Data Terminal, was not ready for trialling when the climatic trials took place. Not fully trialling equipment in extreme climates means that additional risk is carried into the production programme. In the case of the key Bowman equipments, climatic risks appear not to have impacted on system performance.

3.6 In developing any new military capability sufficient time needs to be allowed to digest and act upon the results of early trials. This was especially true for Bowman CIP because of the need to diagnose the often complex reasons for failures. It was frequently unclear how far these were due to human factors or technical factors, particularly as progressively larger scale trials involving more users affected the performance of the system. The compressed timescales allowed for only limited early usability trials. This meant that problems discovered during hot and wet climatic trials could not be clearly attributed to the climate because there was no baseline established under normal European temperatures. For example, a recurring problem with batteries encountered during successive climatic trials in September 2003, June 2004 and August 2004 was eventually traced to a production issue.

3.7 In March 2004 the Department decided that Bowman was sufficiently mature for it to be declared as meeting its target In Service Date on schedule. The decision was made subject to 27 provisos, spanning 18 of the 19 Key User Requirements, (details are given in Appendix 5). Twenty-five provisos remained extant at the time of the recast programme 18 months later.[18] They related to a range of issues, including the overall flexibility and management of the system and the performance of certain data terminals and radios. It can be sensible to declare an In Service Date as achieved subject to provisos, in order to make useful capabilities available to the Armed Forces as soon as possible.[19] The decision made for Bowman has helped speed the delivery of useful capability. It also provided a commercial incentive for the contractor, (paragraph 1.4). But the declaration of the In Service Date for Bowman tended to raise the expectations of early Users, which could not be met during 2004 and 2005 due to the continuing immaturity of much of the system and the significance of the provisos.

3.8 In December 2004, faced with a similar decision in respect to the In Service Date for CIP, the Department decided against declaring the date achieved. At that time, of the 11 CIP Key User Requirements, ten either had major or significant shortfalls in capability and only one requirement had been met. It has continued to develop the initial system on the basis of evidence from the trials that a minimum capability could be put in the hands of Users, and to allow further work to proceed. In March 2006 the Department decided to declare CIP as being In Service, backdated to December 2005. This is subject to a further 32 provisos, (summarised in Appendix 5), raising the total for the combined Bowman CIP programme to 52, all to be resolved by 2007.

3.9 In December 2005 the Department and General Dynamics UK reached an agreed position on a recast programme for Bowman and CIP, which has set a more realistic timescale for the delivery of most remaining capabilities, including the removal of provisos. The recast programme is discussed in more detail in Part 4 of this report. The original timescale for full operational capability has been accepted as having been over-ambitious, and needing to be extended by two years from 2005 to 2007.

The full costs of delivering the capability have emerged since the contracts were signed

Procurement costs have increased despite extensive assessment work

3.10 **Figure 12 overleaf** provides details of the approved costs for Bowman and CIP. When the Department selected General Dynamics UK to deliver the Bowman equipment capability in 2001, it took assurance on the robustness of procurement cost estimates from a number of factors:

- In total some £397 million (16.5 percent of the total procurement cost) had been invested in the earlier aborted procurement, which could be equated to assessment phase activities.[20] This work added to confidence that key new components such as radios would perform as required. However, in May 2005, the Department wrote off £51 million of the £397 million, as not having been effective expenditure.

18 As of March 2006 this number of extant Bowman provisos reduced to 20.

19 The National Audit Office Report Ministry of Defence: *Accepting Equipment off contract and into service*, February 2000, HC 204, recommended that the Department makes more use of provisos to secure early operational benefits where there are performance difficulties.

20 The intended outcome of an assessment phase is to achieve a mature understanding of the future project and the associated risks, with those risks being quantified and mitigated where possible. In this case the investment was above the 15 per cent threshold for up-front investment set as guidance under the Smart Acquisition initiative.

- Three risk assessment contracts totalling £30 million had been awarded to General Dynamics UK and the other two bidders in November 2000 to help identify and reduce technical and programme risks. A further £38 million of risk reduction work took place during early development.
- In parallel, a separate assessment phase for CIP had proceeded between September 2000 and July 2002, to design a system to meet the requirements that would not be met by Bowman itself.

Costs of integration with other systems have emerged

3.11 It was always recognised that Bowman CIP would link to other existing and projected communications and information networks, such as Skynet and Cormorant. But it is only as the Department's wider vision for Network Enabled Capability has evolved that further potential linkages have been confirmed and prioritised, **(Figure 13)**. Recognising the uncertainties, the Department chose to retain in-house the task of defining the respective integration and interface responsibilities of the Contractor on the various Communications, Command and Control systems and projects. Under the contract General Dynamics UK are providing technical interfaces with other systems. To sustain progress, General Dynamics UK has worked directly with other companies to address integration, and to tackle difficulties with regard to United States technology transfer and company intellectual property.

3.12 Bowman CIP is required to carry Battlefield Information System Applications (BISAs) for new battlefield systems for artillery fire control, air defence, combat engineering and nuclear, biological and chemical protection (Figure 13). Work to integrate these systems with Bowman CIP is proceeding, mainly at General Dynamics UK's laboratories in South Wales. The Department, General Dynamics UK and other contractors have together created a Joint Systems Integration Body which began operation in 2003 to mitigate the technical risks.[21] It is too early to say how far this new body has improved the co-ordination of activity between Bowman CIP and the battlefield systems, though the Contractors and the Department are positive about progress to date. In parallel, the Department have established a Joint Networks Integration Body involving General Dynamics UK, EADS and Paradigm, which is a joint venture to ensure end to end communications between the Department's communications systems, Bowman CIP, SkyNet, FALCON and Cormorant. Finally, an Interim Design Authority has been set up by the Department and General Dynamics UK, to integrate Bowman CIP into future platforms.

12 Cost growth on the procurement phase of the Bowman CIP Programme

	Range of estimated outturn costs[1] £ millions (outturn prices)			**Revised approval** (as at Jan 2006 (for Bowman CIP combined))
	Lowest	**Most Likely**	**Highest**	
Bowman: Cost of Demonstration and Manufacture Phase forecast at Main Gate: August 2001	1,874	1,898	2,041	
Combat Infrastructure Platform (CIP): Cost of Demonstration and Manufacture Phase forecast at Main Gate: 2002	317	343	379	
Total	2,191	2,241	2,420	2,536[2]

Source: Major Projects Report 2005 and Revised Departmental Approval for Bowman CIP, January 2006

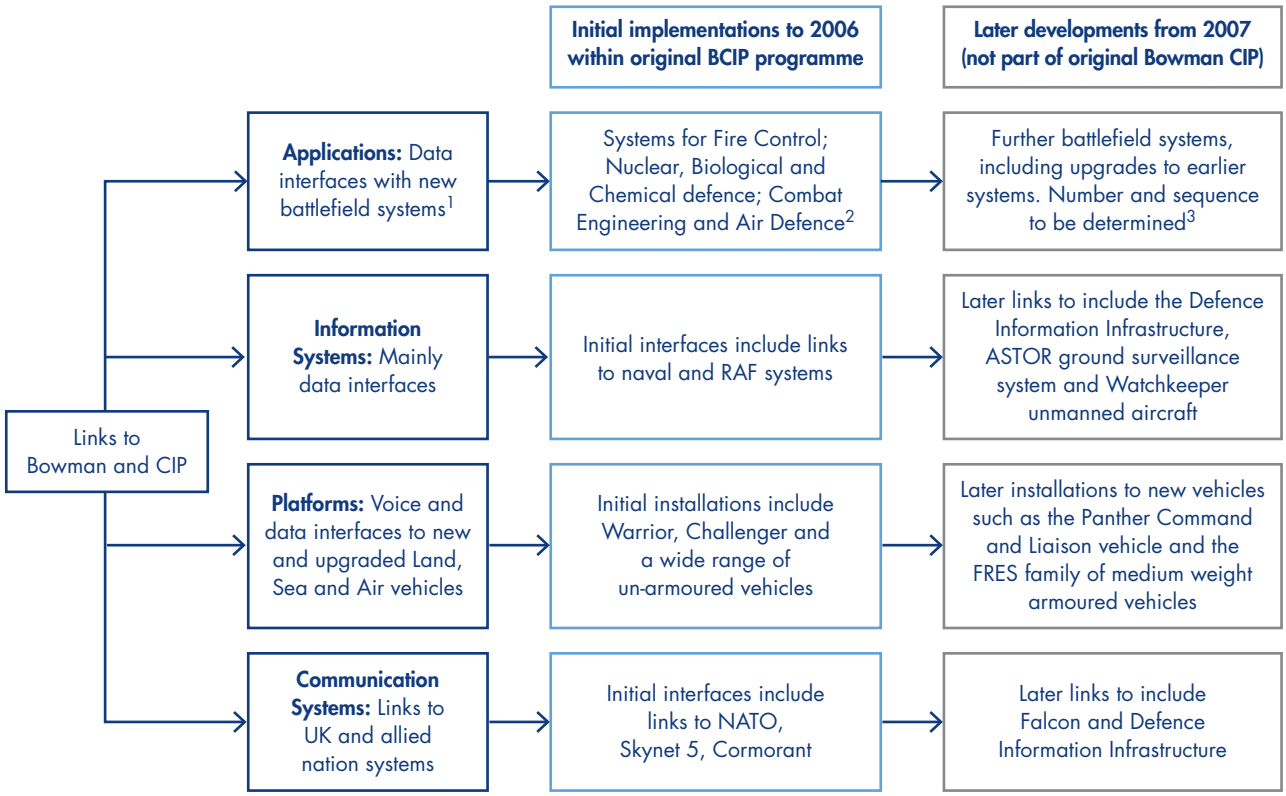
NOTES

1 The lowest, most likely and highest estimates of cost are associated with 10 per cent, 50 per cent and 90 per cent confidence levels respectively.

2 At 50 per cent confidence level.

21 In the course of the programme the Department and General Dynamics UK identified a need to ensure that digitization is delivered in a co-ordinated and coherent way. The Joint System Integration Body (JSIB), a new partnering arrangement between the Company and the MOD, acts as the interface between the teams procuring and supplying BISAs and the Bowman CIP programme. In the longer term, as Bowman CIP and Core Digitization BISAs are delivered, it will continue to support the integration process for new and updated BISAs and related systems to join the growing NEC structure. The Air Defence BISA has now completed System Integration with BCIP 4 and is now undertaking its own Systems Acceptance trials and limited fielding.

13 Bowman and CIP lie at the heart of plans for future Network Enabled Capability



Source: National Audit Office

NOTES

1 Battlefield Systems are a vital element of the drive to network enabled capability. They will depend on Bowman CIP to provide their infrastructure and communications channels. The first four systems are being developed in parallel with Bowman CIP.

2 The intent was to deliver Bowman CIP, the Fire Control system and Air Defence Capability as a package by the In Service Date of March 2004. The latter is currently in the trials stage. The original project approval also included hosting of Combat Engineering and Nuclear Biological and Chemical systems. **The Fire Control** System is being developed to provide a digitised system for targeting artillery fire, enabling gun targets to be adjusted manually or automatically. **The Nuclear, Biological and Chemical** system will provide an improved warning and reporting capability. The Air Defence system will integrate and enhance existing missiles into an overarching **Air Defence** structure.

3 Under the Recast programme, (Part 4), Bowman CIP will need to host additional systems. Though not covered in the BCIP approval, the Key User Requirement called for capability to host future systems.

Costs of delivering support were under-estimated

3.13 Bowman CIP will require a range of support services, such as the provision of spare parts, maintenance and repair facilities, and a capability for continuing design services, to sustain it over the 25 years of its estimated life. As shown in **Figure 14**, the system will comprise between two to three times as many major components (or electronic "boxes") as Clansman, with proportionate implications for the scale and range of necessary support. However, when the projects were approved, the expectation was that the costs of delivering support would be kept broadly within the existing funding for Clansman at some £20 million a year. This assertion was based on uncertain evidence. **Figure 15 on page 30** summarises how the Department's approach to planning the provision of support activities has evolved, the risks and uncertainties remaining and the latest estimated costs of provision. Broadly, the support provision for Bowman CIP is now being developed in three main phases:

- **Initial support for the deployment of the first Bowman-converted brigades, including support to operations in Iraq since April 2005.** The current contract with General Dynamics UK provides limited initial support including spares, logistic and technical support to March 2009. As agreed with the Treasury, additional support costs incurred as a result of operational deployments are funded outside the Defence budget. These amounted to £19 million in 2005-06.[22] The deployment of 12 Brigade was supported in theatre by a team of two system management experts from General Dynamics UK. The main lesson learned from this first operational deployment has been that initial stocks of spare parts, and the brigade's forward repair pool, were of insufficient extent for use in this operation, reflecting in part the lack of real data on Bowman system usage on operations.
- **An interim support arrangement to cover the introduction of Bowman and CIP up to March 2009.** The Department has recognised that the initial support provision included within the Bowman contract is inadequate and negotiations are proceeding with General Dynamics UK to agree firm prices for enhanced support (Figure 15).
- **A longer term support solution to cover all or part of the period from 2009 to 2030, taking into account experience gathered during the earlier phases.** The Department plans to sign this contract in 2008, depending on a business case in 2007.

Costs of delivering training were under-estimated

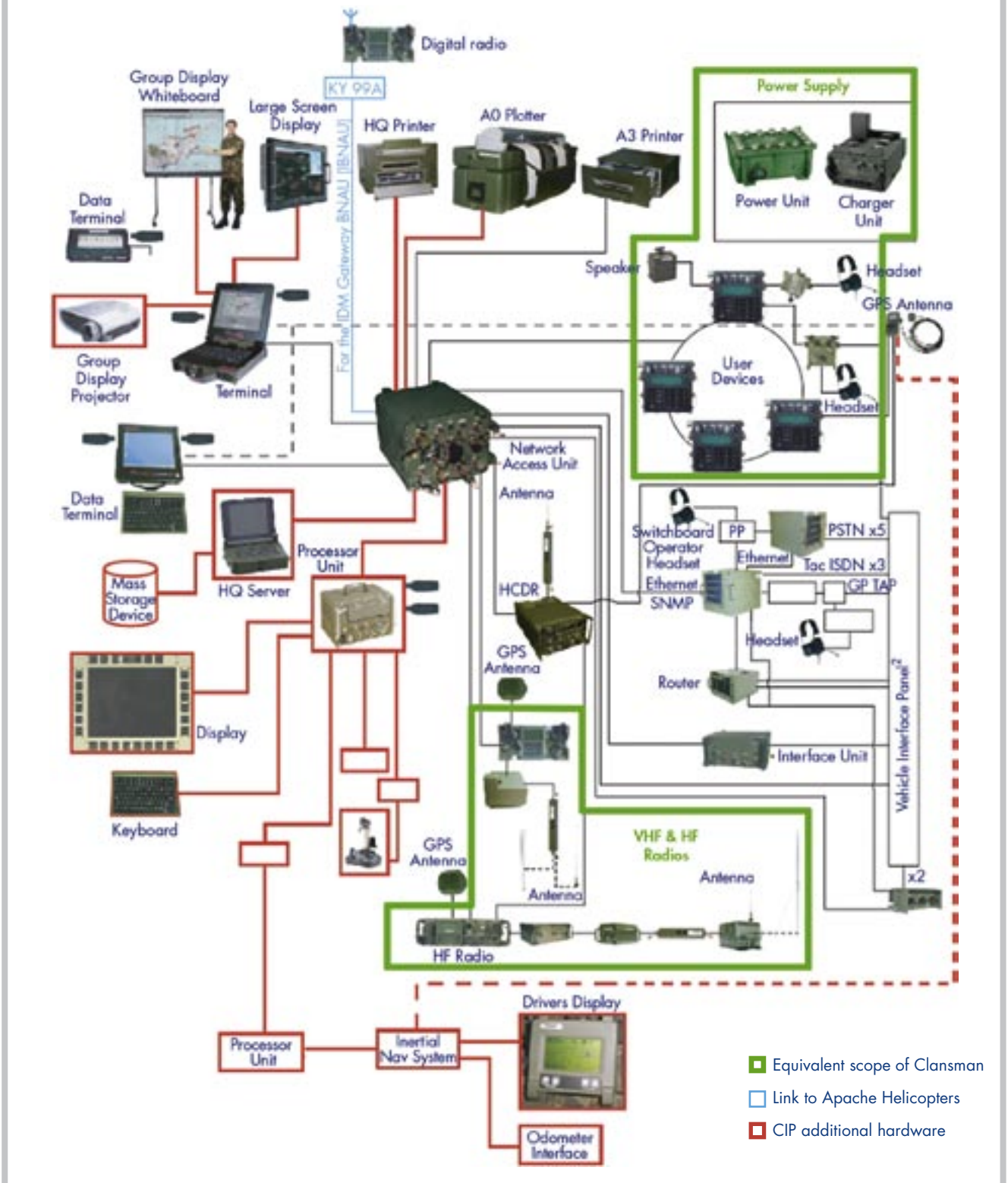
3.14 In 2001, the Department assumed that after the Armed Forces had been converted to Bowman the cost of training should be no more than that for Clansman. Subsequent experience in trials and in Iraq shows that this is unlikely to be the case. Bowman CIP provides functionality far beyond that of a voice radio, and training will also be required for understanding, working and managing its additional data transfer and situational awareness capabilities. Key Users such as system administrators who will manage radio networks will require still higher level skills. There is also a concern that soldiers without regular access to the equipment will experience skill-fade, and new recruits will also require induction to the system. Reports from early Users indicate that, though highly functional, Bowman CIP equipment is not intuitive to use and requires regular continuity training if the system is to be used to its full potential.

3.15 In September 2002, a training needs analysis was undertaken by the Army Training and Recruitment Agency which concluded that the required training could not be delivered through the strategy provided for in the Bowman and CIP contracts. The number of computer-equipped classrooms provided to the Army Training Agency under the Bowman CIP Contract has been increased from 21 to 71 because:

- the assumption had been made that personnel already in "Bowmanised" Units would have depended on their units for refreshers and updates on Bowman. No provision had been made for Commanders and Staff to train to use the advanced capabilities to be delivered through CIP; and
- the original plan for new recruits and appointees was based on centralised instruction in few locations, which would have meant that Bowman training would have been generalised, and detached from training on each soldier's relevant Service, such as Infantry or Artillery.

22 Comprising spares £14 million, and technical support £5 million, for Telic 6 and 7, lasting one year.

14 Bowman/CIP together provide much more extensive equipment and functionality than Clansman



NOTES

1 In the interests of clarity, not all components are individually identified.

2 The Interface Panel provides links to other systems, including telephone networks.

15 The development of Bowman CIP system support costs

Support element	Basis of cost estimates at approval[1]		Latest estimate	Areas of uncertainty
	Bowman	CIP		
Design, technical support and updates for the system in service	NIL change. The main Bowman contract included provision for only a basic support service. This omitted key elements, such as continuing/post design services, contractor repair of failed items, and hardware warranties beyond the first year.	£64 million for ten years. The business case noted that software licences, integration and testing would be key cost drivers. Modelling was being undertaken to identify other cost drivers.	A Bridging Capability to support Bowman CIP until 2009 will require additional funding over and above existing provision, currently estimated at £20 million per year between 2007-08 and 2008-09. In the longer term an annual cost could be between £35 million and £85 million, but more work needs to be done to scope this aspect of the service.	The original intention that the Army would undertake future system modifications is being revisited. A timely decision will be important to allow industry and the Army to put in place the necessary long-term support infrastructure. Continuing uncertainty about the balance between support services to be provided by General Dynamics UK and by the Armed Services, in part reflected the immaturity of the Bowman CIP design.
Spares and maintenance	NIL change. Business case stated no net changes to cost of spare parts and maintenance needs, "which should be comparable to those under Clansman", for which steady state provision was then £20 million per year. It was assessed that components should be more reliable than Clansman, offset by the greater size of the Bowman programme.		Normal longer term patterns of spares demand will only start to emerge after the first converted Brigades take up normal training roles.	Early spares consumption by the first two converted brigades, whilst deployed in Iraq, reflected high operational usage of the system. Consumption was at about ten times the level expected for units not deployed on active operations. This has not been a basis to estimate normal spares consumption.
Service Manpower	NIL on a net basis. Business case stated no net changes to service manpower as a result of introduction.		A small increase in the number of specialist signallers has been required in brigade headquarters to handle the much increased sophistication of the system.	The Services are committed to remaining within their manpower ceilings. However, on current projections up to 20/30 new posts are being created for Bowman system management and use, and found by redeployment from other duties.

Source: National Audit Office

NOTE

1 The Department's estimated whole life costs for Bowman in the programme's 2001Business Case were not broken down into their main elements, and working papers were not retained. As a result this analysis, and those relating to training below, is based on statements in the business case rather than financial tabulations.

The Army Training Agency concluded that both these approaches were untenable, and in 2004 the Department approved additional capital costs of £23.7 million, with total costs of ownership of £204 million, over 25 years. Also, the assumption at the start of the programme that users would be required to conduct less radio system configuration due to automation has not yet been proven, and the ever increasing capability and complexity of ComBAT, and the BISAs, is resulting in the emerging requirement for continuation training for staff.

Converting the Land Vehicle Fleet to Bowman has been more challenging than expected

3.16 In addition to a variety of naval platforms and aircraft, as **Figure 16** shows, up to 20,000 land vehicles were to be converted to accept Bowman. Shortcomings in data on the configuration of military platforms has been a longstanding and serious problem and, as we and the Committee of Public Accounts have previously commented, can make modifications more expensive and slower than expected.[23] This has been the case with the conversion of land vehicles to accept Bowman and has been one of the factors leading to additional costs being incurred and to the conversion programme being delayed. In 1998 in a response to the Committee of Public Accounts,[24] the Government stated: *"The Army will begin to derive benefit from the Delivering the Requirements for Unit Material Management System, (DRUMM), after roll-out begins within the next two years, allowing users asset visibility. Although DRUMM does not track an individual equipment's physical location it does record the unit to which equipments are allocated, which provides sufficient traceability to meet the current requirement"*. This information system was cancelled in 2002, and the Department intends that a logistics system specific to Bowman will be used to track Bowman installations until introduction of a new wider system, JAMES 2.

16 Progress in converting platforms to Bowman

	Planned conversion at contract let		Current planned conversion targets		Total converted at January 2006	Comments
	Numbers	Date	Numbers	By date		
Land[1]	19,203	Sep 07	15,700[2]	Dec 07[3]	4,079	
Naval	146	Dec 07	141	Dec 07	58	3 Type 42 Frigates & 3 Type 45 destroyers removed from programme
Air[4]	236	Jan 06	62	Dec 07	0	Trials commenced in February 2006

Source: National Audit Office and Ministry of Defence

NOTES

1 Vehicle range from Land Rovers and trucks to Warrior personnel carriers and the Challenger 2 main battle tank.

2 Numbers are reducing in line with plans for the Future Army Structure.[25] Also the Territorial Army fleet of some 5,000 vehicles is ageing, and may not merit conversion.

3 This completion date will require a rate of 75 vehicles per week compared to the original 60 vehicles per week target, (See figure 19).

4 The original aspiration was to equip some 236 aircraft comprising the main helicopter types supporting land operations – 45 Chinook, 22 Merlin and 169 Lynx. The Lynx attack helicopter is being withdrawn from service and so no long-term action is being taken to improve communications on these helicopters. Also some 67 Apache aircraft are not to be converted. The Department and General Dynamics UK concluded that installing Bowman radios and hardware within the cockpit of the Apache attack helicopter would be extremely difficult. An alternative solution based on transmitting Bowman messages to the Apache via ground vehicles has been designed and tested and is being procured as an interim solution outside the scope of the recast Bowman CIP programme at a cost of £25 million excluding VAT. This solution avoided having to modify and requalify the Apache at major expense.

23 Committee of Public Accounts – Thirty Second Report 1998-99 ISBN: 0105563617, Published: 27 August 1999, HC 300 1998-99. Report by the Comptroller and Auditor General, Ministry of Defence: *Modifying Defence Equipment*, HC 24, 10 December 1998.

24 CM 4471, paragraph 44. Treasury Minute on the Thirty Second Report from the Committee of Public Accounts 1998-99 – Ministry of Defence: *Modifying Defence Equipment*.

25 The re-structuring of the Army, including the reduction in number of Battalions and changes in the way units rotate between roles.

3.17 Both the Department and General Dynamics UK have learned lessons from the challenges of conversion. General Dynamics UK allowed for a certain amount of variation in land vehicles when submitting its bid in 2001, but underestimated the extent of this, much of it legitimate but unrecorded modification undertaken over the years to enable the Army to fulfil its diverse roles. Its estimates were based on the inspection of a small number of "representative vehicles" provided by the Department. The Department did not undertake a general survey of the entire vehicle fleet, which would have been very costly, and impracticable in the time available. Nor was a representative sample taken of vehicle configurations across units in order to help scale the problem before the contract was awarded. In practice, General Dynamics UK's estimate did not prove to be an adequate basis against which to plan the conversion programme, with variations in internal and external configurations within each platform type running at about twice the level expected.[26] **Figure 17** shows examples of the type of variations discovered, which frequently exceeded the tight tolerances allowed for in General Dynamics UK's initial designs. The extent of variation has greatly increased the amount of design work needed and the man-hours required for conversion in General Dynamics UK's workshops, and changed the quantity and mix of materials ordered from suppliers. When vehicles have been different to those expected, the Army has often found it not possible to present alternative vehicles for conversion, one factor being the current high level of operational commitments worldwide.

3.18 The Department noted difficulties with some supplier processes during the early stages of conversion, particularly the delivery of long lead items such as cables, and with the early productivity of some of General Dynamics UK's sub-contractors on design and certification work. Another factor affecting the rate of conversion has been late or incomplete technical or design data from some of the Department's contractors on the configuration of vehicles.

3.19 The effect of these problems has been that General Dynamics UK's workshops operated at much reduced productivity for the first 18 months of conversion. Where the unexpected variations existed when the contract was signed in 2001, General Dynamics UK has borne the additional costs of embodiment. Where additional work has been due to a post-contract modification the Department meets the costs, amounting to £7.4 million to date.

17 Photographs illustrating the nature of variation in the land vehicle fleet

Photograph 1 shows Insufficient space to accommodate Bowman cabling, due to a smaller than expected recess in the fuel tank of a Warrior armoured vehicle. This is difficult to remedy because the recess is immediately under the Warrior's turret ring (removed in this illustration). An example of variation in a vehicle from when it was built.

Photograph 2: The configuration in another Warrior configured as expected, providing the required deeper space for installation of cabling.

Photograph 3: Interior of a Royal Marines tracked vehicle which arrived at General Dynamics with the interior space required for Bowman occupied by a water tank. This is an example of variation in vehicles arising from ad hoc modification in unit workshops, most prevalent in older vehicles. It is particularly difficult to track such local modifications.

Source: National Audit Office and General Dynamics UK

26 In contrast aircraft and naval platforms are subject to more structured configuration control, and unexpected variation should be much less of a problem. Progress to date in converting naval platforms has been much better.

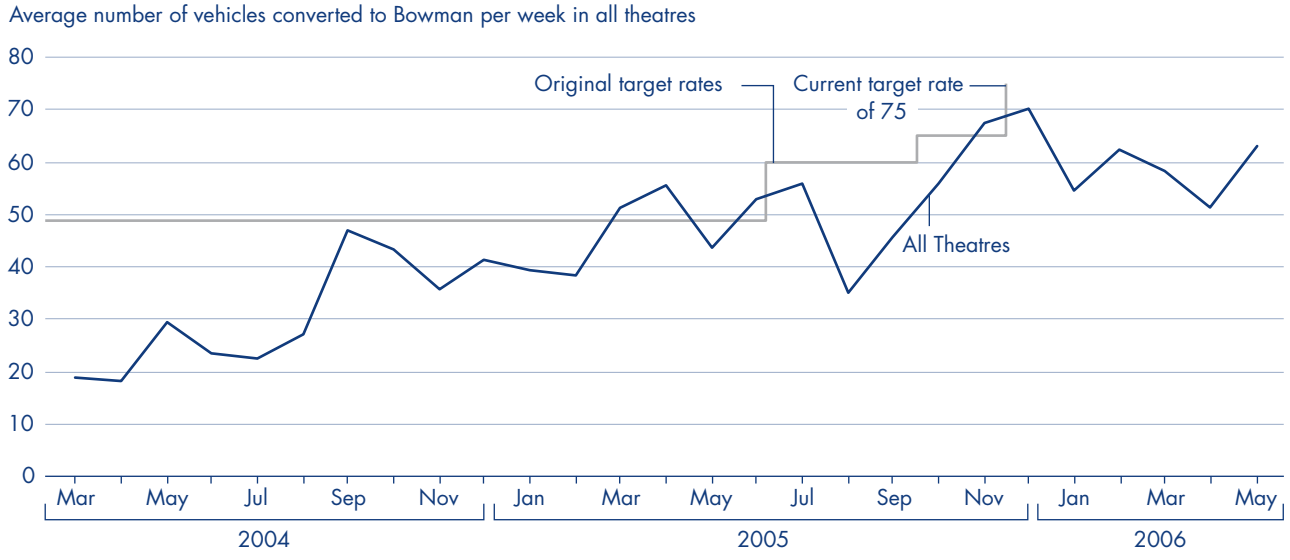
3.20 As **Figure 18** shows, the Department and General Dynamics UK have learned lessons and put in considerable commitment to resolve most of the conversion issues. And, as **Figure 19** shows, the rate of land vehicle conversion has improved, though the programme remains behind schedule. With up to 11,000 more vehicles to be converted, this implies a finish date of at least mid 2008 if the target rate of 60 vehicles per week, only at times achieved, is sustained. So an increased target of 75 vehicles per week, based on the best achievement shown below, was set.

18 How the Department and General Dynamics UK have improved the rate of conversion of land vehicles

- General Dynamics UK has broadly doubled the capacity of its main conversion design facilities and workshops;
- General Dynamics UK and the Department have put more resources into the inspection and preparation of vehicles before they arrive for conversion;
- The Department has brokered increased co-operation between the contractor and those responsible for the design of vehicle types to ensure that drawings are up to date.
- In August 2004 the Department agreed to defer the conversion of 19 Mechanised Brigade from early 2005 until late 2007 to "de-heat" the schedule;
- General Dynamics UK and military liaison officers are working more closely to confirm which vehicles will arrive, at what time, and the configuration to which they will be converted;
- In November 2005, the Department committed to present a sufficient flow of vehicles to enable General Dynamics UK to maximise utilisation of their workshops, if necessary by taking vehicles from more than one Brigade at the same time;
- Other improvements under consideration by the Department include deploying Army maintenance staff to General Dynamics UK's facilities, more direct advance communication between the conversion workshops and Brigades, and the conversion of new vehicles on their original production lines, rather than after delivery.

Source: Ministry of Defence

19 The rate of land vehicle conversion has risen towards targets since conversion began



Source: General Dynamics UK

NOTE

During 2006, an increase in operations combined with other factors has meant that some vehicles have been unavailable for conversion at their allotted time. The conversion team have used available production capacity to convert many, more complex, armoured vehicles. The Department and General Dynamics UK continue to monitor closely whether the remaining production capacity will be sufficient to complete all remaining vehicles by the end of 2007 as planned.

PART FOUR

The Recast Programme reflects a more realistic understanding of the capabilities that can be delivered, though risks and uncertainties remain

4.1 This part of the report considers the extent to which the recast has addressed problems on the programme, and identifies the key technical risks and challenges to delivery of the full Bowman CIP capability. The plan for the future of Bowman CIP, agreed with General Dynamics UK, is more realistic, but risks still remain in the programme, and some technically difficult but still important capabilities are being deferred to a possible later programme.

The recast programme includes additional time and funding to achieve a workable system

4.2 By December 2004 when CIP did not achieve its approved In Service Date, and provisos had not been cleared, it was clear to all parties that the programme was over-ambitious and needed substantial revision.[27] From May 2005 the Department and General Dynamics UK undertook a comprehensive and detailed technical and management review. Progress was maintained on the conversion of vehicles and on system development while the review proceeded. The review culminated in a series of commercial negotiations in October 2005 with General Dynamics UK to agree draft terms for a recast programme presented for investment approval in December 2005.

4.3 The main features of the Department's approach to the recast included:

- independent assessment of the remaining technical and management risks, with input from various sources including the Office of Government Commerce and external consultants;
- early clarification with key stakeholders as to what additional funding the Department was prepared to make available, and with key user representatives as to what military capabilities had to be maintained in the programme, and which could be traded out or deferred; and
- negotiations based on an agreed cost for the recast as a package, accepting that General Dynamics UK would not supply an itemised "shopping list" of capabilities each with price tags from which the Department would choose.[28]

4.4 The £2.5 billion recast programme represents £121 million of additional funding (the increase is analysed in **Figure 20 overleaf**), and a two year extension in the timescale for delivery of a fully working system in-service and free of provisos. The new key acceptance milestone will be field trials in mid-2007. This effectively turns a four year Bowman development programme into a more realistic six year programme; and extends that for CIP from three years to five, whilst preserving the timely delivery of initial increments.

27 The CIP In Service Date was not a contractual commitment on General Dynamics UK.
28 In principle it is desirable that Departments have sufficient information to decide whether individual capabilities are worth the cost. The Department told us that this was not possible in this case, because of the interdependencies between different capabilities, and because General Dynamics UK were not able to attribute costs in isolation.

20 Main cost elements of the commercial settlement for the recast programme

Additional cost £ million	Description	Commentary
121	The costs include elements accepted by the Department as "emergent", or additional to the original requirement. It also includes fixes to data terminals and a replacement "gateway" between Bowman and other MOD radio systems which the Department considers to be changes to how original requirements are to be delivered.	This is essentially the cost for successful removal of provisos attached to the Bowman ISD since April 2004, (Appendix 5 and paragraph 3.7 refer). General Dynamics UK considers some of these, such as the new "Gateway", as in fact due to changed requirements. Paragraphs 4.6-4.7 refer.
0	Mutually extinguished claims by MOD on General Dynamics UK, and vice versa.	Paragraph 4.5 refers. The settlement is subject to successful future joint management of the issues.
121	Total additional cost to Defence	Equates to a cost escalation of five per cent on original programme cost.
Includes 10	Funding for a validation phase for a possible future stage of development for CIP.	Paragraph 4.8 below refers. There is no commitment to proceed to a future Bowman CIP 6. The Department has provisionally estimated likely costs at some £200 million.

Source: National Audit Office and Ministry of Defence

4.5 During the negotiations General Dynamics UK identified potential claims on the Department worth some £52 million, the largest of which were for alleged disruption to the Contractor's vehicle conversion work, caused by the Army having provided the wrong type, or non-compliant, vehicles, (Paragraph 3.17 refers); and the Department's failure to provide viable sites to accommodate training classrooms. The Department responded by citing various issues which it felt were the Contractor's responsibility and which might lead to counter-claims. These were deemed to have a negotiating value of up to £180 million, the most material relating to the performance of radio batteries. Though this was higher than the Contractor's claims, the Department considered them to be more vulnerable to challenge and likely to be discounted if pursued. As part of the overall settlement both parties agreed to take no further action on potential claims, and agreed to work together more closely to resolve difficulties.

The Programme has been recast to meet the most immediate capability requirements

Essential changes to the solutions necessary to meet system requirements have been accommodated

4.6 The principal changes made to the Bowman CIP programme, (Figure 20), reflect the way that changes in the external environment impact on a high technology programme like Bowman CIP. Some could be described as "new", but most have evolved from deeper understanding of what is required, or from the need to keep up with developments in technology and security in the outside world:

- The 2001 contract made the contractor responsible for ensuring that the system would meet then extant security standards. Subsequently security authorities have required an upgraded level of security. The Department has accepted £8 million of the total £10 million cost.
- Updates have been required to Bowman CIP connections to the Global Positioning system and to Operating Systems, both of which became outdated in the four years since the contract was let.

- The Department considered that the Contractor's proposed "Gateway" link between Bowman and other Defence communication systems would be too unwieldy. A more portable smaller, lightweight, system, not available in 2001, is being provided.

4.7 The Department and General Dynamics UK have differing perspectives on how much of the £121 million additional funding represents new or changed customer requirements, and how much represents the cost of delivering what was always envisaged. As stated above, there was no itemised list of items with prices in the recast negotiation. The Department maintains that the main user requirements have not changed. It has estimated that up to half the £121 million reflects items such as those in paragraph 4.6 above which it considers as changed technical solutions rather than changed requirements. It also notes that the cost includes "fixes" to key components such as data terminals, and solutions to enable the data radio network to be more flexible (paragraphs 4.11-4.15 below). General Dynamics UK's position is that they have delivered their contractual requirement, and that cost changes such as these in paragraph 4.6 represent new or evolved system requirements, delivering enhanced technical solutions to deployed operations.

4.8 At the time of writing this report, the Department is assessing the extent to which the recast Bowman CIP Programme will generate tangible benefits and savings for other Defence equipment programmes. For example, radios no longer required for the conversion of legacy platforms (Figure 16) may be used to equip new vehicles, ships or aircraft, reducing the cost of those programmes.

Some capabilities have been forgone or deferred to a possible future programme

4.9 As part of the recast programme the Department has sought to establish more realistic time and cost goals against the minimum essential capability. It has deferred some still-evolving and technically difficult capabilities, to be assessed in a new £10 million validation phase taking place in 2006-07. This will take account of changes, since the contract was let, in thinking about Battlespace Management and in the international context, particularly interoperability with foreign allies. The assessment will identify the technical risks of further development of the system up to 2010, taking into account all the systems that will have to interface with Bowman CIP. This will inform the Department's decision on whether or not to fund extra work. The principal deferrals, which the Army regards as of very high priority, are:

- Multi-lateral interoperability data exchange: to allow exchange of situational awareness information with coalition (including US) partners. This capability is particularly important in the light of combat identification incidents in recent conflicts, and only some of this will be included in the recast programme for delivery by 2007;
- The ability to host further Battlefield Information Systems applications beyond the first four already being incorporated, (Figure 13 refers); an important capability given the vision of Bowman CIP as a platform for Network Enabled Capability, and
- The ability to retrieve and share information quickly through an advanced information management system; this capability being important given the much greater volumes of data likely to be generated by Bowman and CIP.[29]

Technical risks remain in the recast programme

4.10 Despite good progress in providing secure voice communications, Users have experienced problems managing Bowman CIP to secure the capabilities envisaged on the recast programme. The following paragraphs explore the main risk areas, many of which would impact more on Users' ability to operate very large Bowman CIP networks in major war fighting, rather than smaller scale peace support operations as currently being sustained in Iraq.

29 The Department has also foregone CIP capabilities including war-gaming facilities and a range of mission planning tools, which user representatives accept as having lower priority.

Sustaining the tactical internet

4.11 There have been significant technical difficulties with the development of a mobile tactical internet to support data transmission. During field trials in late 2004 the Army's 12 Mechanised Brigade found it not possible to achieve a reliable working network consisting of more than 75 high capacity data radios. This compared with original requirements for a brigade level deployment of some 240 such radios, a divisional deployment of up to 600 radios, and a design maximum of up to 1020. The high capacity data radio was a system selection made by the previous "Archer" consortium, which General Dynamics UK agreed to inherit when it took over the Bowman programme in 2001. General Dynamics UK has since worked with radio suppliers to identify the reasons for this underperformance, and has made some progress in the field. The Company has achieved a stable network of 120 radios in laboratory and field conditions, and is testing its performance in vehicles with increasingly reliable and robust results. If this remains the practical ceiling then the Armed Forces may need to provide for additional system management resources to establish and manage links between 120-radio networks in order to ensure coverage for larger military deployments. General Dynamics UK and the Department are confident that a workable data radio network will be delivered, although there may be implications for how other battlefield systems will use it.

Operational deployment has helped to confirm the main issues to be resolved by the recast programme

4.12 Early experience of Bowman CIP in trials revealed numerous issues, some of which have at times been reported in the public domain, with varying degrees of accuracy, and some of which have continued to be publicly aired after they have been resolved. There is not space to address them all in this report, which focuses on those which should have most significance for future military capability.

4.13 Under the initial version of Bowman, communications planning for data transmissions has involved unacceptably lengthy processes that are intolerant to even trivial errors and can only be undertaken by experts. The deployed initial version also allows little flexibility to enable the rapid regrouping of forces, especially at the tactical level, unless such changes have been pre-planned. So in practice Users need to build up a library of the different ways in which a brigade or battlegroup sized formation, and its supporting data radio network, might be need to be reconfigured.

4.14 There is currently insufficient flexibility for Users to join the network. Users are fixed to one work station and vehicle, meaning that if Users need to access Bowman from different platforms or locations to the one they are assigned to, the data network will not allow them to do so.

4.15 General Dynamics UK believes it has now successfully addressed persistent problems reported from trials over intermittent loss of radio transmission. Though the current remedy is convoluted for users, the next version of the system is planned to provide an automatic solution.

4.16 Adapting Bowman CIP to the specific needs of operations in Iraq required the delivery of a number of urgent operational requirements. Ensuring sufficient technical support in the field has been subject to trial and error. The scale and parts range of the Army's Forward Repair Pool had taken into account the rates of component and system failures experienced in the most recent Operational Field Trials in the United Kingdom, but were not sufficient for the greater and different demands of real operational deployment. This led to delays in fielding Bowman spares packs and pressures on army communications teams (see paragraph 3.13). General Dynamics UK has provided local technical support to the armed forces in Iraq, initially without the cover of a contract. General Dynamics UK figures show that 98 per cent availability of Bowman equipment has been achieved in Iraq, in part by resorting to outright replacement as opposed to repair in forward areas.

APPENDIX ONE

National Audit Office Methodology

Statement of methodology

In undertaking this examination we:

a Designed the examination having regard to recognised **best practice** principles in programme management, principally the Ministry of Defence's "Smart Procurement" initiative, and the Office of Government Commerce's "Managing Successful Programmes."

b Deployed to the study **NAO staff** with relevant prior British Army experience, particularly in command and control functions.

c Commissioned specialist **external advice** and analysis from experts in military communications.

d Attended and observed **Field Trials** of Bowman CIP equipment, and assessed the outcome from Army field trial and operational reports.

e Visited key **contractor facilities** operated by General Dynamics UK, gathering direct visual, photographic and aural evidence on the difficulties of converting land vehicles to Bowman, and training facilities to understand the computer based initial training on the system.

f **Interviewed initial users** of Bowman CIP functionality, particularly 12 Mechanised Brigade, from Brigade Commander via Headquarter Signal Specialists, to other ranks.

g Noted experience from programmes in **Battlefield Digitisation overseas**, including Canada and the USA. Our findings do not feature prominently in this report, given the differences between different countries' context and for reasons of space, but they helped inform our views on the difficulty of the Bowman CIP undertaking.

h Undertook **triangulation** of our evidence gathered from various sources using an **Evidence Database** we designed for that purpose. This proved important given the sheer volume and range of documentary evidence generated by such a large and complex programme.

i Used the database to generate specific **common questions** to Programme participants, to resolve or better understand areas of conflict or disagreement. This minimised the extent of disagreement with our findings during subsequent clearance of the draft report.

j **Triangulated** our findings **externally** with those of other parties undertaking scrutiny of Bowman CIP, including the Office of Government Commerce, the Department's Chief Scientist, and Internal Audit.

k **Extended the study scope** to incorporate further work on the Department's negotiations in late 2005 with the Contractor to recast the programme, focusing on trade-offs made between cost, time and capability.

Though the scope of our examination was defined as a review of the current Bowman CIP programme which has existed since 2001, we necessarily reviewed background documentation extending back to the mid-1990s to better understand the Bowman context.

Further detail on specific approaches

Interviews with Stakeholders

We interviewed all the key stakeholders identified in Figure 9 of this report. Our work benefited from openness and ready co-operation, including during periods when participants were heavily committed to recasting the programme.

Contribution from Consultants

Systems Consultants Services Limited are experts in military Command, Control, Communications, Computers and Intelligence systems. In early 2005 we commissioned them to conduct in-depth analysis of the Department's Operational Analyses of Bowman CIP (effectively, why the equipment was needed and what benefits it would bring), as well as an examination of the programme risks and risk management arrangements. We also took their advice on a continuing basis. Results were shared with the Department as soon as available, to inform its decision-making and to ease subsequent clearance of our report.

Documentary Evidence

We have evaluated evidence from many hundreds of documents connected directly or indirectly to the Bowman CIP programme. Key examples of documents we reviewed are as follows.

Document	Role and contribution
Acceptance and Release Documents	The minutes of monthly meetings held by key stakeholders. A summary of the minutes goes to ministers. Evidence of what the key risks, priorities and challenges are in the programme, on a month-by-month basis.
Concept of Use	Describes the ways in which the new equipment would be used to bring benefit to the UK Armed Forces.
Integrated Test and Evaluation Plan	Describes in detail the method by which the equipment was to be tested, trialled and accepted.
Operational Field Trial Reports	Reports the findings from Operational Field Trials. Evidence of progress and problems with the equipment.
Review Notes	Jointly written by the IPT and Prime Contractor, they review the programme for the Investment Approvals Board, recommending a programme plan with regards to time, cost and performance. The Board then advises Ministers on whether to agree to the recommendations, which often ask for increased resources.
Through Life Management Plan	A plan describing the path through which the ComBAT, DBL Infrastructure and Platform BISA capability will be procured, delivered into service and managed through life until its disposal.
Training Needs Analysis	An analysis of the training needs required by the introduction of the new equipment. This formed the basis of the BOWMAN Supply and Support Contract with General Dynamics (UK).
Land Digitization Plan, 2003	The Army plan to deliver enhanced Command and Battlespace Management. The plan states that this is the Army's top equipment priority as well as a significant step towards a Networked Enabled Capability.

APPENDIX TWO

Chronology of key events

Including successive conclusions of the Committee of Public Accounts and the NAO (italics)

A: Early history

1988 – Bowman feasibility studies launched.

1993-1996 – Bowman Project definition stage. Two consortia, CROSSBOW headed by ITT and YEOMAN headed by Siemens Plessey Systems (SPS) and Racal.

30 November 1995: Major Projects Report 1994 Committee of Public Accounts

"We are concerned that delays in bringing new equipments into Service also have military implications. We note, for example, that slippage on the Bowman project, which is currently over four years late, has resulted in the United Kingdom having to operate radios based on 1960's technology, which are becoming increasingly vulnerable to electronic counter measures. We look to the Department to make all possible efforts to bring Bowman into Service without further delay."

1996 – Termination of the original Bowman competition. Archer Communications Systems Limited (ACSL), a joint venture company, is formed by ITT, SPS and Racal.

1997 – MOD selects Archer as prime Bowman contractor, with competition at sub-contractor level.

May 1998 – NAO Report Major Projects Report 1997:
Paragraph 1.29 *"There is an urgent need to replace Clansman which has significant operational deficiencies, and is expensive to maintain. Any further delays to the Bowman programme may put the project at risk of cancellation in favour of an alternative solution. As a result, the Department are under some pressure to place a production contract as quickly as possible. The National Audit Office note that the Department are continuing to evaluate fallback options. However, in pursuing the current strategy, the Department need to balance the pressure to proceed quickly against the potential weakening of their negotiating position which can result from time constraints".*

October 1998 – Award of Bowman supply and support contract to Archer.

October 1999 – Equipment Approvals Committee (now the Investments Approvals Board) approved the continuation of Bowman contract, given a de-scoped solution within acceptable time and cost.

December 1999 – MOD announced it planned to deliver the system incrementally. Initial deliveries of stand-alone Personal Role Radios (PRR) would now come before Bowman.

6 July 2000: NAO Major Projects Report 1999.
Paragraph 3.27 *"Similarly, on the technically complex Bowman project, a number of risks have matured which were not fully considered or evaluated when the original In Service Date was set. In particular, neither the Department nor industry were able to take full account of the effect which the rapid pace of technological change, and the corresponding increase in Users' expectations, would have on demand. For example, Users data transmission needs increased tenfold between 1988 and 1996. These factors contributed to the collapse of competition on the project in 1996. Since 1996 the Department has committed to an advance of some £200 million of development work as risk reduction aimed at producing a technically compliant and affordable solution before commitment to the main contract".*

16 August 2000: Major Projects Report 1998 Committee of Public Accounts

Conclusion (xv): Bowman, a tactical communications system, was due to enter service in 1995. The programme is now running some six years late resulting in a significant capability gap for the Armed Forces. The Department assured us that they have reviewed their requirement very carefully and are seeking to make maximum use of commercially available off the shelf items to provide an affordable and timely solution. Getting Bowman into operational use nevertheless remains a major task in terms of the numbers of equipments to be procured and installed, the technology involved and the training required.

A number of elements of the Archer programme were carried forward from the previous contract, some of which were mandated.

B: Chronology of the current procurement

January 2000 – Contracts let to seek costed proposals for a Bowman fallback option.

July 2000 – Decision taken to re-launch the competition for the Bowman contract.

21 December 2000: Committee of Public Accounts Ministry of Defence: Kosovo – The Financial Management of Military Operations

Conclusion (ix): There were significant weaknesses in communications in-theatre, particularly in tactical communications, where continuing delays in the Bowman radio system have left our soldiers dependent on the insecure and unreliable Clansman systems. The Department should act quickly to provide stop-gap secure communications for future deployments in the continued absence of Bowman.

September 2001 – New Bowman contract signed with General Dynamics UK, then Computing Devices Canada, the Bowman Prime Contractor.

28 November 2001: Committee of Public Accounts – Major Projects Report 2000

Conclusion (ix): It is unacceptable that the Department has wasted between £35 million and £102 million in pursuing an unworkable solution to the Bowman requirement. We expect the Department to minimise the amount written-off and to be able to demonstrate that it has utilised the results of the abortive Bowman expenditure to good effect (paragraph 24).

We also note the Department's assurance that three-point estimates for Bowman will be available soon and expect all projects in the Major Projects Report 2001 to have robustly generated three-point estimates.

20 August 2002. Committee of Public Accounts Report on Ministry of Defence: Combat Identification

Conclusion (v): The Bowman communication system will provide a stepchange in capability and be a key enabler for improving Combat Identification. The Department is now confident that Bowman is finally on track. Given the programme's long and troubled history, we will follow the progress of the programme both in meeting its current In Service Date of 2004 and in delivering the promised operational benefits in our examination of future Major Projects Reports.

December 2002 – Ministers announce an extension to the Bowman contract to deliver the ComBAT battle management system, its associated infrastructure and the integrated capability for complex fighting platforms (collectively known as CIP – ComBAT (Common Battlefield Application Toolset), Infrastructure and Platform Battlefield Information System Application (CIP)). The MOD sought to exploit the close links between the programmes by aligning the development and fielding of CIP with the Bowman programme.

July 2003 – First unit (1 Royal Anglian battalion) begins converting to Bowman.

December 2003 – The first Battalion Operational Field Trial took place.

March 2004 – The first Brigade Level Operational Field Trial took place, 12 Mechanised Brigade.

March 2004 – Bowman (less CIP) declared In Service but with provisos.

July 2004 – An additional Brigade level Operational Field Trial (OFT 1a) took place to reassess CIP.

26 November – 4 December 2004 – The second Brigade Level Operational Field Trial took place.

December 2004 – CIP was granted Initial Acceptance but failed to achieve full In Service Date.

January 2005 – MOD decides to review the programme to put it on a realistic time schedule: a deliberate choice not to try to address provisos at undue speed. 42 Commando Brigade Royal Marines commenced conversion. The bulk of this unit's vehicles were completed in 2005.

February 2005 – Commander in Chief LAND decides to deploy elements of the Bowman communications system with 12 Brigade to Iraq on Operation TELIC 6.

February to August 2005 – Landing ships and other naval platforms complete conversion.

November 2005 – 7 Brigade deploy on Operation Telic 7 as the first fully Bowmanised Brigade. 3 Commando Brigade trials the system in the Amphibious Exercise Bowman Vanguard – a key test for littoral (or coastal) capability. It included the transfer of command from on board ship to a Commando headquarters ashore.

December 2005 – Following successful exercise, operational readiness was declared for use in littoral environments, as planned.

February 2006 – Limited Acceptance, with 4 provisos, granted for Apache-Bowman connectivity and In-Service Date for Secure Voice Rebroadcast capability backdated to May 2005.

March 2006 – CIP In Service Date declared with effect from December 2005.

APPENDIX THREE

Performance against approved key user requirements as declared by the Department

From MOD Major Projects Report 2005

Bowman

21 Performance against approved key user requirements

Serial	Key Requirement	Forecast to be Met	At Risk	Not to be Met
01	Secure Voice.	Yes	–	–
02	Secure Data.	Yes	–	–
03	Automatic Position Location, Navigation and Reporting service.	Yes	–	–
04	Security.	Yes	–	–
05	Ease of Use.	Yes	–	–
06	Provide automated system management enabling support to the full spectrum of operations.	Yes	–	–
07	Data Communications Infrastructure.	Yes	–	–
08	Support the Common Infrastructure for Battlefield Information Systerms concept and provide a common operating environment for Digitization Stage 2.	Yes	–	–
09	Allow the free-flow of data and voice within and between vehicles, groups of stationary vehicles, and other systems.	Yes	–	–
10	Provide a secure and robust tactical internet service making efficient use of limited bandwidth.	Yes	Yes	–
11	BOWMAN is to support current operational C2 doctrine, practice, deployment and battle procedure.	Yes	–	–
12	BOWMAN is to provide interfaces to other key battlefield communication systems used at the tactical level.	Yes	–	–
13	BOWMAN equipment is to meet a level of survivability consistent with its physical environment and misson criticality for 95% of users in 95% of likely climatic conditions.	Yes	–	–
14	Make effective, robust use of the Electro-Magnetic Spectrum without degrading other systems.	Yes	–	–
15	BOWMAN is to provide working installations in all platforms designated as containing BOWMAN equipment, except for ships, WAH-64 and Lynx aircraft for which equipment is to be provided but not installed.	Yes	–	–
16	Health and Safety.	Yes	–	–
17	Supportability.	Yes	–	–
18	Training.	Yes	–	–
19	BOWMAN is to supply sufficient scales of equipment and services to meet the needs of those forces taking part in or supporting land operations, as structures at end of supply (EOS).	Yes	–	–
Percentage currently forecast to be met			100%	
In Year Change			0	

CIP

22 Performance against approved key user requirements

Serial	Key Requirement	Forecast to be Met	At Risk	Not to be Met
		Yes		
01	Situational Awareness.	Yes	–	–
02	Planning.	Yes	–	–
03	Co-operative Working.	Yes	–	–
04	Interoperability.	Yes	Yes	–
05	Hosting Battlefield Information Systems Application.	Yes	–	–
06	Latency.	Yes	–	–
07	Common Information.	Yes	Yes-	–
08	Platform Fightability.	Yes	–	–
09	Platform System intergration.	Yes	–	–
10	Graceful Degradation.	Yes	–	–
11	Sustainability.		–	–
Percentage currently forecast to be met			100%	
In Year Change			0	

APPENDIX FOUR

Case Study: The PRC 354 Section level radio

Each eight-strong Infantry Section was to be issued with one of these VHF radios, which had to be portable when the soldier carrying it was on foot. The radio has a 5 km range, to communicate between the Section and other units. Though bigger and heavier than its Clansman equivalent it has much more capability, in areas such as security, data handling and location reporting.

Sequence of key Events:

Letter from Headquarters Infantry to the Bowman Digitisation Military Team, November 1998	"The bottom line is that whatever happens we can not accept a portable radio that is bigger than its predecessor… The role and method of operation of the Infantry make weight and volume critical factors… More radio means less ammunition means more casualties". Further letters from HQ Infantry at this time repeat the point that a portable radio heavier than its predecessor was not acceptable to the Infantry. (The Bowman Digitisation Military Team was closely involved in setting the specification for Bowman at this time).
Letter from Headquarters Infantry to Army Force Development branch, February 1999	"My concern is that decisions are being taken now concerning fundamental aspects of Bowman without reference to the Infantry Trials and Development Unit and HQ Infantry and we could find in 2002 and beyond that… Bowman does not match our aspirations" (Force Development Branch co-ordinates planning for the Army, including remedial action to close gaps in capability).
The Department's requirements document issued to bidders. 1999	"It is desirable that weights, inclusive of a single battery should be as above table [which states the Man-pack radio should be no heavier than six kilograms] plus no more than 20% by weight and volume. However, initial trial results have indicated that the size and weight for the VHF Portable Radio may not be attainable if the full requirements for voice and data are to be met. The contractor may, therefore, propose size and weights in excess of these requirements if it can be demonstrated that these: a. *Are operationally acceptable to the user; b. Realise significant reductions in risk, cost or timescale*". (Italics NAO)
The Bowman Concept of Use document. October 2000,	States that the new portable radio should be lighter than the Clansman: "For the man-portable equipment, the existing Clansman equipment already impose a number of operational constraints on the User which need to be resolved by Bowman, particularly in view of the potentially more mobile role in future operations. The whole load of the equipment includes the provision of spare batteries, as required, to cover a full 24 hour battlefield day. The critical aspect is the total weight of the complete man-portable radio installation, which the infantry soldier is required to carry… This includes the User Data Terminal and other ancillaries, as well as their associated power supplies. If this total weight is excessive then there will be operational penalties, the severity of which will be directly proportional to the extent by which the offered equipment exceeds the stated values in the BPR[1], both for size and weight."

Sequence of key Events *continued*:

2000-2005	Exchanges continued between HQ Land, HQ Infantry, the Infantry Trials and Development Unit, the Assistant Chief of the General Staff, DEC CCII, General Dynamics UK and the IPT about this issue, however with no resolution. In 2003, the Director of Infantry was still making clear his view that the weight was excessive: The PRC 354 is not acceptable for use in Dismounted Close Combat in its current form"[2] and again in 2004: "Radios with associated batteries for a 24hr mission are above the KUR weight limits (by over 1.5kg) as specified in the Bowman SRD".[3] While there is evidence to show that this was raised with the Integrated Project Team, with Headquarters Land Command and with the Assistant Chief of the General Staff, the weight still exceeds the original Staff Requirement[4] specification for a manpack radio, inclusive of battery, of 6kg (the PRC 354, inclusive of ancillaries and batteries to last a 24hr period, weighs 6.16 kg). The Department has pointed out that other users, such as the Royal Marines, do not consider the weight of the radio to be unacceptable.
OUTCOME	A way forward has now been agreed. It is intended that another programme will deliver an upgraded PRC354 against an amended set of user requirements. In recognition of this, the Department has closed the relevant Bowman Proviso (see Appendix 5 proviso 26). The cost of this programme is yet to be determined.

NOTES

1 Bowman Performance Requirements.

2 Letter from HQ Infantry, 18 December 2003.

3 Letter from HQ Infantry, 06 August 2004.

4 Letter from Deputy Directorate of Operational Requirements (Communications and Surveillance), 1 February 1999.

APPENDIX FIVE

Progress in resolving provisos to the Bowman In Service Date

The Department granted the Bowman Radio system in-service status in March 2004 subject to 27 provisos. The table shows the extent of progress against these, and seven have been removed, though many are not now expected to be removed until March 2007. Further provisos relating to CIP are summarised at the end of this appendix.

- Red: high risk to proviso clearance; solution often unknown
- Yellow: limited progress, or insufficient evidence/ trends yet to comment on risk to proviso clearance
- Green: proviso on course to be cleared, albeit that the date may slip to BCIP05 fielding by April 2007

Proviso	Key User Reqt	Issue to be resolved	Progress as at 30 November 2004	Status as at November 2005
1	Gen	Voice transmission/Data transmission/and Automatic Position Location, Navigation & Reporting (APLNR) all working together	No data with APLNR on Personal User Data Terminal. The High Frequency radio has "data only" networks	Forecasted clearance: Operational Field Trial in March 2007. The Key risk remains the performance of the High Capacity Data Radio to sustain positional reporting.
2	Gen	Thorough Technical Field Trials before field trialling and use by field units	Ongoing. Revised trials/de-risking schedule working well	Forecasted clearance: Before March 2007. Work on an improved system acceptance strategy is under way to determine the best mix between field trials and other forms of testing.
3	Gen	No compromised Key User Requirements to remain by the time of Full Operational Capability	Ongoing	Ongoing
4	1	High Frequency voice/data, connected to Vehicle Internal and External Distribution Systems	Procedural constraints currently. No High Frequency arbitration solution for Bowman CIP 2005	Forecasted clearance: Operational Field Trial in March 2007. Contractor has agreed to deliver a new proposal for meeting user requirements.
5	1	HF skywave to work voice/ data, including Automatic Position Location, Navigation & Reporting	Vehicle broadband antenna (new requirement) procurement ongoing	Forecasted clearance: Acceptance and Review Meeting 7. Increased availability of antennae
6	2	Personal User Data Terminals delivered and trialled to full scaling	Future of Personal User Data Terminals under review	Forecasted clearance: Operational Field Trial in March 2007. Number of terminals has been reduced from 18,000 to 11,000, due to their unsuitability for some uses. Replaced with lightweight terminals.

Proviso	Key User Reqt	Issue to be resolved	Progress as at 30 November 2004	Status as at November 2005
7	3	Automatic Position Location, Navigation & Reporting working at full scaling	The weakness is the Personal User Data Terminal	Forecasted clearance: Operational Field Trial in March 2007. Various technical improvements under way.
8	3	Demonstrate reliable and accurate mapping data	No acceptable mapping solution demonstrated on Personal User Data Terminal	Forecasted clearance: Operational Field Trial in March 2007.
9	4	Achieve full security accreditation	Personal User Data Terminals in Local Area Subsystem vehicles only for two years and cannot be downgraded	Forecasted clearance: Operational Field Trial in March 2007. Dependent on Software changes and possible changes in security standards.
10	5	User Data Terminal pointing device resolved	Mice used for Operational Field Trials. Longer-term solution not agreed for SUDT/BMDT [Define]	Forecasted clearance: Operational Field Trial in March 2007. Limitations of existing data terminals is the main constraint.
11	5	VHF voice/data arbitration demonstrated	Subject to confirmation on a Technical Field Trial	PROVISO CLEARED in 2005
12	6	Appropriate, usable system management tools to enable user to establish, maintain and change voice and data networks.	Bowman Communications Management System is complex and user-unfriendly. No easy checking of CI plans	Forecasted clearance: Operational Field Trial in March 2007. Changes in response to 111 of 112 known problems agreed. Limitations of data terminals addressed by use of 2000 commercial laptops.
13	6	Ability to monitor High Capacity Data Radio traffic levels	Commercial "Off The Shelf" monitoring tool (Simple Network Management Protocol) is the current fallback	Forecasted clearance: Operational Field Trial in March 2007. Need for a genuine tool to monitor network traffic levels to be agreed.
14	7	Demonstrate message distribution within Headquarters	Recommendation: clear this proviso	Forecasted clearance: During 2006. Given planned messaging improvements.
15	8	Fire Control and Air Defence capability over Bowman	No Fire Control BISA. No BISA capability for dismounted Users	Forecasted clearance: Operational Field Trial in March 2007. Many system improvements in train but some remaining issues.
16	8	BOWMAN and CIP provide warfighting capability	No Domain Name Service solution – requires pre-planned deployments, limits regrouping	Forecasted clearance: Operational Field Trial in March 2007. Still dependent on acceptable performance from a High Capacity Data Radio.
17	9/10	BOWMAN data network must be stable and robust	Then max 74 High Capacity Data Radio nodes. No VHF mode B with this radio	Forecasted clearance: Operational Field Trial in March 2007. Progress is encouraging but still technically challenging. HCDR improvements are intended to yield stable networks of up to 240 radios.
18	11	Data service must allow roaming and regrouping by Users	No Domain Name Service solution in place, so pre-planned deployments only	Forecasted clearance: Operational Field Trial in March 2007. Still a combination of risk factors.

Proviso	Key User Reqt	Issue to be resolved	Progress as at 30 November 2004	Status as at November 2005
19	11	High Capacity Data Radio robust over 7–10 km links	Recommendation: consider clearing this proviso, but note stability	PROVISO CLEARED
20	12	Interoperability: With existing Ptarmigan and Cormorant radio systems	Ptarmigan: limited voice, no data. Cormorant: voice demonstrated	Forecasted clearance: Operational Field Trial in March 2007.
21	13	Meet environmental survivability KURs	Climatic trials ongoing. Issues: battery, charger and Bowman Gateway Equipment performance	Forecasted clearance: Possibly End 2007, but issues being assessed. Limits of current battery technology are being reached, and contractor will supply additional spare batteries and chargers.
22	14	Bowman and the Single Channel Access Radio work alongside each other to give isolated or mobile Users an entry point into the legacy Ptarmigan system	Recommendation: clear this proviso, Army's Command Support Development Centre to confirm procedures	PROVISO CLEARED
23	14	Radio frequency clearances obtained from national authorities in Canada, Germany, Poland	Progressing. No High Capacity Data Radio deployed overseas outside a single barracks in Germany	PROVISO CLEARED December 2005 on understanding that further progress will be made as routine business.
24	15/16	Customer 1, Customer 2 and Defence Procurement Agency agree Closure Plan for 12 Brigade		PROVISO CLEARED: December 2005 Plan Agreed for retrofit of 12 Brigade vehicles.
NEW	15/16	Conversion to be completed by end 2007 Modifications required to enable system start-up within 3 minutes for some vehicles	NEW	Some risks to timely completion of conversion by end 2007. This will require a sustained conversion rate higher than the 60 per week target. Contractor proposals on system start-up awaited
25	16/18	A MOD-led support solution to be trialled and demonstrated. Continued contractor support until this is achieved.	Demonstration on second Operational Field Trial and two weeks after. Limited Bowman Logistic Information System for second Operational Field Trial.	A logistic demonstration is required before this proviso is to be removed. An in-service exercise is planned within the next two years, subject to agreement with Land Command and the availability of units.
26	19	An acceptable man platform must be in use – the PRC 354 section level radio.	Gooseneck; CQB and 1.2m antenna; cables; KDU lock; BMRC, VP pouches all cut-in to production. SA over KDU and Personal User Data Terminal review ongoing. Batteries/weight is key issue and under constant review	PROVISO CLEARED: December 2005 Though the radio meets the contracted requirement, Director Infantry considers that the weight and ergonomics make it unsuitable for use in dismounted combat. Alternative options outside the Bowman programme are under consideration.
27	19	Brigade Operational Field Trials conversion shortfalls made good		CLEARED. 12 Mechanised Brigade now complete

Summary: November 2004. 27 Provisos – Eight Red, Eleven Yellow, Eight Green. November 2005: 25 Provisos – 11 Green, 14 Yellow, these since reduced to 20.

Summary of further provisos relating to CIP as at March 2006.

Area of Proviso (Figure 4 refers)	Number of provisos
The Platform BISA delivering CIP in Armoured Vehicles	11
The ComBAT battle management system	9
Compliance with Security Standards	3
Functionality of CIP in Brigade Headquarters	3
Battlefield Information System Applications (paragraph 3.12)	2
Other aspects of CIP system performance	4

NOTE

The number and nature of provisos changes on a frequent basis. At the time of writing none were rated "Red - high risk to proviso clearance; solution often unknown".

APPENDIX SIX

Glossary of Terms

Battlespace: All aspects of air, surface, subsurface, land, space and the electromagnetic spectrum that encompasses the area of operations, area of influence and area of interest in a campaign.

Battle Management System: The generic term for command and information systems for deployed land forces.

Concurrency: In the context of programme management, a situation in which a project has many simultaneous or overlapping activities, for example where development work is still continuing while early versions of the equipment are being rolled out to users.

Command: The authority vested in an individual of the Armed Forces for the direction, co-ordination and control of military forces.

Command Development Centre: Provides a focus for developing Command and Control and Command Support capability for Land operations by Joint and Multinational forces.

CORMORANT: A military, formation-level, communications and data transfer system. CORMORANT is to provide the operational level communications facilities for a deployed Joint Rapid Reaction Force (JRRF). It is air-portable and will provide voice and data services between the theatre of operations and the United Kingdom via satellite. CORMORANT will offer Joint and Combined interoperability between the Joint Force Commander, Component Commanders and Allies.

Digitize: To exploit the information opportunities offered by digital technology in order to deliver increased capability.

Doctrine: Fundamental principles by which the military forces guide their actions in support of objectives. It is authoritative but requires judgement in application.

FALCON: Ptarmigan trunk communications replacement.

Information Management: The means by which an organisation maximises the efficiency with which it plans, collects, organises, uses, controls, disseminates and disposes of its information, and through which it ensures that the value and potential value of that information is identified and exploited to the fullest extent.

Initial Gate:	A relatively low approval hurdle, between the Concept and Assessment Phases, intended to encourage early and full exploration of a wide range of options for meeting a particular capability. A Business Case at Initial Gate should confirm that there is a supportable User Requirements Document and a well constructed plan for the Assessment Phase and beyond with a good chance of a successful outcome. Approval at Initial Gate conveys no commitment on the customer or the approving authorities to a project proceeding to or beyond Main Gate.
Integration:	In terms of computer-based systems, is the process which allows data from one device or software to be read or manipulated by another, resulting in ease of use.
Integrated Project Team:	The body responsible for managing a project from Concept to Disposal. Its main tasks include developing the System Requirement, devising equipment solutions to meet that requirement, and managing the procurement and in-service support of the equipment. Under Smart Procurement the IPT is characterised by "cradle-to-grave" responsibility, inclusion of all the skills necessary to manage the project, and its effective and empowered leader.
Integrated Project Team Leader:	The person with the overall responsibility for the IPT, and the line manager of all its core members.
Intelligence:	The product resulting from the processing of information, both overt and covert, concerning foreign nations, hostile or potentially hostile forces or elements, or areas of actual or potential operations. The term is also applied to the activity which results in the product and to the organisations engaged in such activity.
Interoperability:	In the operational context, this is the ability of systems, units or forces to provide services to and accept services from other systems, units or forces and to use these services to enable them to operate effectively together; in the technical context, "interoperable systems" describe the ability of multiple systems, with a common standard in their design, to share and exchange data and work together in a seamless fashion within a federation of systems. Use of the expression "interoperable systems" implies that systems will be able to exchange email and that data on one system can be used by an application running on another. It therefore implies a common interface standard, including data and compatible security policies (although not necessarily the same security level).
Joint:	Activities, operations, organisations etc: in which elements of more than one Service of the same nation participate.
Land Command:	Land Command's role is to deliver and sustain the Army's operational capability, wherever required through out the world, and the Command comprises all operational troops in Great Britain, Germany, Nepal and Brunei, together with the Army's Training Teams in Canada, Belize and Kenya.
Land Command Digitization Working Group:	The Land working group whose aim it is to be the focus within Land Command for the introduction of Bowman and Digitization.

Land Digitization Steering Group:	The 2 Star Steering Group, chaired by ACGS, the aim of which is to ensure that the full implications arising from Digitization and associated matters are identified and addressed.
Multinational:	Adjective used to describe activities, operations and organisations, in which forces or agencies of more than one nation participate.
Network Enabled	Network Enabled Capability offers decisive advantage through the timely provision and exploitation of information and intelligence to enable effective decision-making and agile actions. It involves joining up Defence systems in a "network of networks".
Operation:	A military action or the carrying out of a strategic, tactical, service, training, or administrative military mission; the process of carrying on combat, including movement, supply, attack, defence and manoeuvres needed to gain the objectives of any battle or campaign.
Other Operations:	Other operations are those that are conducted in situations other than war; it replaces "Operations Other Than War" to reflect the need for similar combat capabilities in situations short of warfighting.
Programme:	As defined by the Office for Government Commerce, a portfolio of projects and activities that are co-ordinated and managed as a unit, such that they achieve outcomes and realise benefits.
Senior Responsible Owner:	The individual ultimately responsible for successful delivery.
Situational Awareness:	The understanding of the Operational environment in the context of a commander's mission. In the context of Bowman, each radio has a built in Geographical Positioning System processor that is programmed to update all other radio users connected to the network.
Sustainability:	The ability of a force to maintain the necessary level of combat power for the duration required to achieve its objectives.
Tactical Internet:	In the context of BOWMAN CIP, radio communications sub-systems are connected to provide a tactical internet; a range of computers that provide messaging, situation awareness and management information; a local area sub-system that interconnects data terminals and voice users within a vehicle or group of vehicles forming a headquarters; and connections to other communications systems.
Urgent Operational Requirements:	Are used for the rapid procurement of capability in support of a current or imminent military operation, through a fast-track, streamlined version of the Department's acquisition procedures.
Vehicle System Integration:	This defines a common set of Standards, Architectures and Protocols that will enable the operationally effective use of both on and off platform command and control data within the Digitized Battlespace.

REPORTS BY THE COMPTROLLER AND AUDITOR GENERAL, SESSION 2005-2006

The Comptroller and Auditor General has to date, in Session 2005-2006, presented to the House of Commons the following reports under Section 9 of the National Audit Act, 1983. The reports are listed by subject category.

		Publication date
Cross-Government		
Home Office: Working with the Third Sector	HC 75	29 June 2005
Joint Targets	HC 453	14 October 2005
Progress in improving government efficiency	HC 802-I/II	17 February 2006
Second Validation Compendium Report: 2003-06 PSA data systems	HC 985	23 March 2006
Improving the efficiency of postal services procurement in the public sector	HC 946-I/II/III	24 March 2006
Smarter food procurement in the public sector	HC 963-I/II/III	30 March 2006
Update on PFI debt refinancing and the PFI equity market	HC 1040	21 April 2006
Achieving innovation in central government organisations	HC 1447-I/II	25 July 2006
Culture Media and Sport		
Procurement in the Culture, Media and Sport sector	HC 596	30 November 2005
The office accommodation of the Department for Culture, Media and Sport and its sponsored bodies	HC 942	16 March 2006
Defence		
Driving the Successful Delivery of Major Defence Projects: Effective Project Control is a Key Factor in Successful Projects	HC 30	20 May 2005
Managing the Defence Estate	HC 25	25 May 2005
Assessing and Reporting Military Readiness	HC 72	15 June 2005
Major Projects Report 2005	HC 595	25 November 2005
Progress in Combat Identification	HC 936	3 March 2006
Reserve Forces	HC 964	31 March 2006
Using the contract to maximise the likelihood of successful project outcomes	HC 1047	7 June 2006
Delivering digital tactical communications through the Bowman CIP programme	HC 1050	21 July 2006
Education		
Securing strategic leadership for the learning and skills sector in England	HC 29	18 May 2005
Extending access to learning through technology: Ufi and the learndirect service	HC 460	4 November 2005
Employers' perspectives on improving skills for employment	HC 461	14 December 2005
Improving poorly performing schools in England	HC 679	11 January 2006
Environment, Food and Rural Affairs		
Lost in Translation? Responding to the challenges of European law	HC 26	26 May 2005
Environment Agency: Efficiency in water resource management	HC 73	17 June 2005
The right of access to open countryside	HC 1046	9 June 2006

		Publication date
Europe		
Financial management in the European Union	HC 999	29 March 2006
Law, Order and Central		
Public Guardianship Office: Protecting and promoting the financial affairs of people who lose mental capacity	HC 27	8 June 2005
Home Office: National Asylum Support Service: The provision of accommodation for asylum seekers	HC 130	7 July 2005
Returning failed asylum applicants	HC 76	14 July 2005
National Offender Management Service: Dealing with increased numbers in custody	HC 458	27 October 2005
The Electronic Monitoring of Adult Offenders	HC 800	1 February 2006
Crown Prosecution Service: Effective use of magistrates' courts hearings	HC 798	15 February 2006
Serving Time: Prisoner Diet and Exercise	HC 939	9 March 2006
The Management of Staff Sickness Absence in the National Probation Service	HC 1042	26 April 2006
Department for Constitutional Affairs: Fines Collection	HC 1049	25 May 2006
National Health Service		
Innovation in the NHS: Local Improvement Finance Trusts	HC 28	19 May 2005
The Refinancing of the Norfolk and Norwich PFI Hospital: how the deal can be viewed in the light of the refinancing	HC 78	10 June 2005
A Safer Place for Patients: Learning to improve patient safety	HC 456	3 November 2005
Reducing Brain Damage: Faster access to better stroke care	HC 452	16 November 2005
The Provision of Out-of-Hours Care in England	HC 1041	5 May 2006
The Paddington Health Campus scheme	HC 1045	19 May 2006
The National Programme for IT in the NHS	HC 1173	16 June 2006
Improving the use of temporary nursing staff in NHS acute and foundation trusts	HC 1176	12 July 2006
Overseas Affairs		
The Foreign and Commonwealth Office: Consular Services to British Nationals	HC 594	24 November 2005
Department for International Development: Tsunami: Provision of Financial Support for Humanitarian Assistance	HC 803	1 March 2006
Department for International Development: Working with Non-Governmental and other Civil Society Organisations to promote development	HC 1311	6 July 2006
Public Private Partnership		
Progress on the Channel Tunnel Rail Link	HC 77	21 July 2005
The Wider Markets Initiative	HC 799	27 January 2006
The Termination of the PFI Contract for the National Physical Laboratory	HC 1044	10 May 2006

		Publication date
Regions and Regeneration		
Office of the Deputy Prime Minister: Enhancing Urban Green Space	HC 935	2 March 2006
A Foot on the Ladder: Low Cost Home Ownership Assistance	HC 1048	14 July 2006
Regulation		
The Office of Fair Trading: Enforcing competition in markets	HC 593	17 November 2005
The Office of Gas and Electricity Markets: Sale of gas networks by National Grid	HC 804	10 February 2006
Re-opening the post: Postcomm and the quality of mail services	HC 944	22 March 2006
The creation of Ofcom: Wider lessons for public sector mergers of regulatory agencies	HC 1175	5 July 2006
Revenue departments		
Filing of Income Tax Self Assessment Returns	HC 74	22 June 2005
Corporation Tax: companies managed by HM Revenue and Customs' Area offices	HC 678	13 January 2006
HM Revenue & Customs: VAT on e-commerce	HC 1051	26 May 2006
HM Revenue & Customs: ASPIRE – the re-competition of outsourced IT services	HC 938	19 July 2006
Trade and Industry		
The closure of MG Rover	HC 961	10 March 2006
The restructuring of British Energy	HC 943	17 March 2006
Supporting Small Business	HC 962	24 May 2006
Transport		
Maintaining and improving Britain's railway stations	HC 132	20 July 2005
The South Eastern Passenger Rail Franchise	HC 457	2 December 2005
A5 Queue Relocation in Dunstable – Wider Lessons	HC 1043	28 April 2006
Work and Pensions		
Gaining and retaining a job: the Department for Work and Pensions' support for disabled people	HC 455	13 October 2005
Department for Work and Pensions: Dealing with the complexity of the benefits system	HC 592	18 November 2005
Department for Work and Pensions: Using leaflets to communicate with the public about services and entitlements	HC 797	25 January 2006
Department for Work and Pensions: Delivering effective services through contact centres	HC 941	15 March 2006
Child Support Agency – Implementation of the Child Support Reforms	HC 1174	30 June 2006
International benchmark of fraud and error in social security systems	HC 1387	20 July 2006
Progress in tackling pensioner poverty: Encouraging take-up of entitlements	HC 1178-I/II	21 July 2006

Printed in the UK for the Stationery Office Limited
on behalf of the Controller of Her Majesty's Stationery Office
5392680 07/06 65536