Weapons

Dr Gina Lindsley
Team leader
Agenda

- Introduction & Overview
  Gina Lindsley
- FY09/10 Highlights
- Defence Technology Plan
  Chris Leach
- Complex Weapons CDT IOC
  Guy Tomlinson
- FY10/11 Delivery Plan
  Gina Lindsley
- Summary
Scope of Weapons Domain

- Key Technologies
  - Modelling tools
  - Energetics
  - Warheads & Fuzing
  - Guns & Rockets
  - Directed Energy Weapons (Laser & RF)
  - Seekers
  - Guidance
Scope of Weapons Domain

Applications

- General munitions and complex weapons
- Engagement of air & surface targets from air, land and maritime platforms
- Tactical STA
- Joint fires Integration
Scope of Weapons Domain

Key Technologies
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Technology Readiness Levels 1 - 4 & beyond
Context and Future Challenges

Extracted from SDR Green Paper Feb 2010:

- **Recent Operations:**
  - Joint operations have become the norm
  - Our ability to integrate our activities across land, sea and air ....has meant that the sum is greater than the parts
  - Networking our forces - by integrating sensors, decision-makers and weapons systems - has multiplied their effect

- **Future Battlespace:**
  - Characterised as **Contested, Congested, Cluttered, Connected and Constrained**
Context and Future Challenges (contd)

Technology:

• Some emerging technologies may radically change our understanding of conflict or our ability to conduct operations
• The changing threat can rapidly negate an assumed technological edge
• We will need to be more agile to:
  – adjust our programmes to access the right technology in response
  – exploit new technologies to enhance our capabilities
• We must increase our use of spiral or modular development, to provide the capacity to upgrade as new technologies become mature or new threats emerge
Implications for Weapons

- Affordable precision remains a key thrust
- Ability to deliver proportionate effect is important
- Understanding of benefits/implications of networking weapons is vital
- Modularity and Open System Architectures is a priority requirement which must be addressed
- Need to maintain broad technology watch and a clear understanding of sovereign technologies
- Need to balance sustainment vs emerging technology

- Defence Technology Plan captures the specific requirements for weapons research
Programme Planning & Delivery

Significant progress over last 18 months in joint planning & joint programme delivery:

- Within MoD - Joint Technology Planning Group
- With Industry – UK E, MCM ITP, CW CDT, CDE
- International Partners
  - UK/US Hazard Assessment, DEW
  - UK/ Fr Energetics, MCM ITP, Indirect Fire, Rockets, various demonstrator & acquisition programmes
FY09/10 Highlights
Team: Cranfield University, Lockheed Martin, Logica, MBDA, QinetiQ, Selex Galileo and Thales

Purpose: Assessment, development and risk reduction for integrated weapons in an NEC environment

Achievements:
- Assessment Framework
- Synthetic environment development
- Support to SPEAR and Datalink projects
- Synthetic Environment exploitation in other progs: Sensor to Effect (S2E2), CW CDT and CW Pipeline programmes
- S2E2 project will demonstrate Network Ready Weapon in live fire trial (Summer 2011)
Directed Energy Weapons Research

- **High Power Electronic Devices (HiPED)**
  - Aim: to undertake underpinning technology research into innovative compact high power RF sources
  - Underpinning RF DEW technology solutions. Components technologies for system applications.
  - Well focussed EW ToE derived teaming, industrial and academic participation.

- **Electronics Defeat Capability Vision**
  - Assessing the vulnerability of electronic systems
  - Focussed look at what might be possible – details classified
  - Concept phase successfully completed on time
  - Handed off to DE&S
  - Technology pull-through from HiPED

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**Weapons**

Defence Research 2010

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Materials & Components for Missiles ITP

- **Aim**
  - To deliver cost effectively the research needs of MoD and DGA whilst building the technology base of a future European complex weapon capability

- **Key principles**
  - £2.5M (MoD) and 3.5M€ (DGA) per annum customer funding
  - 3 year contract extending to 5 years
  - Low ‘TRL’ research
  - High level of innovation
  - Matched self-funding by industry
  - Contribution from SMEs and academia to progress innovative technologies
  - Collaborative research projects

- **Achieved to date**
  - Joint technical strategy across government and industry
  - Over 70 projects launched
  - More than 50 research providers
  - SME/Academia contributing 27% of total value
  - 50/50 joint funding achieved

- MCM ITP conference October 2010, www.mcmitp.com
Example Projects:

- Carbon Silicon Carbide thrusters
- Anti Fast In-Shore Attack Craft (FIAC) Fuzing
- Rocket motor thrust control developments
- Mitigation of High Speed Fragments for IM munitions
- Feasibility of Ka Band MEMS switches
- Maturing of GaN Power sources
Demonstration of First UK LEEFI

- Chemring and QinetiQ have developed and demonstrated a UK Low Energy Exploding Foil Initiator (LEEFI)

- UK LEEFI Advantages:
  - Reduced operating voltages
  - Component miniaturisation
  - Improved system integration
  - Not subject to export licence issues

- Potential for integration into a TME fuze for a range of Team CW weapons
MEMS Initiator and SAU for Future Fuzes

Achievement
- Research funded MEMS Initiator and Safety & Arming Units (SAUs) is being exploited by Junghans and QinetiQ for application in munitions

Benefits
- Miniaturised SAU & Fuze devices for munitions with severely restricted payload envelope

Future Plans
- Fabricated at QinetiQ’s UK foundry
- Test firings at QQ & Junghans test facilities
- Close collaboration to design devices that are viable for production
Low Threshold Tracking for Countering Low-RCS Air Targets

**Aim:**
- Enhance ability to track low-RCS targets such as micro-UAVs & rockets
- Increase detection range for currently detected targets

**Background**
- A direct response to CDE call on Countering Difficult Air Targets

**Key principles**
- Expected Likelihood Particle Filter (ELPF) tracker gives similar benefits to TkBD without access to raw radar data
- ELPF reduces false alarms cf use of low threshold

**Achieved to date**
- Proof of principle
- Exploits existing tracking and data association capability
- Technique offers benefit without demanding changes to legacy systems
- Application to specific sensors ongoing
Weapons ITT Expenditure FY09/10
Weapons ITT Expenditure FY09/10 by Theme

- Complex Weapons (incl CDT): 7%
- DEW: 4%
- General Munitions: 3%
- Sppt to Ops / CPF: 2%
- WLC & Safety: 1%
- CDE / Innovation: 2%
- Strategy & Advice: 4%
- CDAT: 18%
- Underpinning Tech & Tools: 43%

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Defence Technology Plan

Dr Chris Leach
STL Effectors

Unclassified Internet Version refreshed Feb 2010.
Available under
www.science.mod.uk
Research Planning

Defence Technology Strategy
MoD Customer
Defence Industrial Strategy

Research Goals
Research Vision

Defence Technology Plan
Research and Development Objectives
Delivery Plans
Dept Strategy

Dstl Programme Office

Defence Research 2010
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Research and Development Objectives (RDOs)

- Weapons Domain delivers 5 RDOs from the DTP

- Two Effects orientated RDOs
  - Joint Effects Against Surface Targets
  - Countering Difficult Air Targets

- Three Technology orientated RDOs
  - Network Enabled Complex Weapons
  - S+T Challenges in the Design and Ownership of Weapons
  - Emerging Technologies: Disruptive High Power Technologies
Joint Effects Against Surface Targets

- Improve the delivery of effects (timely, proportional)
- Improve operational effectiveness in close proximity to own forces
- Precise, timely effects
  - Improve effectiveness against mobile & relocatable deep targets
  - Improve warning and location accuracy of IDF threats

- Surface Based Close Support
- Truly integrated Joint Fires capability from land, naval and air assets with timely, proportionate effect at reduced footprint

- Concept of Operations
- Integrated Survivability
- Legislation Compliance
- Deep fire Rocket Systems
- Platform Integration
- Weapon Locating Sensors
- Armed UAVs
- Deployment Aids
- Networking
- Land Effects Studies
- Air Weapons Studies
- System Integration
- Sensors
- Data Links
- Joint Fires Integration
- Enhanced Precision
- Controlled Effect Ammunition
- Improved Charge Systems
- Training Requirements
- Autonomous & Automation
- autofill
Joint Effects Against Surface Targets RDO

- Desired Outcome
  - Concepts, advice, Science and Technology for an integrated Joint Fires and Surface Attack capability from land, naval and air assets to prosecute surface targets with a timely and proportionate effect

- Research Themes
  - Countering Indirect Fire Systems
  - Joint Fires Integration
  - Persistent Deep Fires
  - Surface Based Close Support
  - Weapons Concepts, Studies & Analysis
Counter Difficult Air Targets RDO

**Desired Outcome**
- Cost effective, timely concepts and technologies to counter all airborne threats, including those difficult to prosecute by more traditional means

**Research Themes**
- Counter air targets studies and OA
- Counter Difficult Air Targets Effects
- Enablers and Integrated Effects
Network Enabled Complex Weapons RDO

- Desired Outcome
  - Affordable, Defence Industrial Strategy compliant, Complex Weapons solutions which deliver proportionate effects against a wide spectrum of targets, including mobile and relocatable surface targets in selective engagements and challenging environments

- Research Themes
  - Effects
  - Materials & Components for Missiles
  - Net Ready Weapons
  - Networking. Precision & Control
  - Range, Persistence & Survivability
Science & Technology Challenges in the Design and Ownership of Weapons

- Desired Outcome
  - Tools, techniques and technologies which enable the affordable and responsible Through Life Capability Management of weapons with a 50% reduction in the cost of ownership and 50% “quicker to market”. Ensure innovation in the S+T Capability to discharge “duty of care” and legislative obligations in the weapons and wider energetics areas

- Research Themes
  - Concepts, Modularity & Integration
  - Life Prediction
  - Pyrotechnic Countermeasures
  - Reduced Risk of Ownership & Use
  - Training Logistics & Disposal
**Disruptive High Power Technologies RDO**

- **Desired Outcome**
  - To enable MoD to take advantage of disruptive power technologies

- **Research Themes**
  - Develop & Sustain UK Knowledge Base of High Power Technologies
  - High Power Optical Technologies
  - High Power Radio Frequency Semiconductor Technologies
  - Technologies for Radio Frequency Directed Energy Weapons
Complex Weapons
Centre for Defence Technology
(Initial Operating Capability)

Guy Tomlinson
Complex Weapons CDT Vision and Mission Statement

- **Vision:**
  - “Deliver battle-winning technology solutions for Complex Weapons in a timely manner that are mutually beneficial to MoD and Industry”

- **Mission:**
  - “Our mission is to inspire and focus research, and exploit technology and systems to deliver optimum Complex Weapons to the front line at the right time

- **Method:**
  - We will do this by identifying and supporting rapid development and technology pull-through whilst sustaining critical sovereign skills, utilising a responsive and adaptive virtual “centre” that embraces an integrated team of MoD, Academia, SMEs, Primes and Technology Innovators”
Complex Weapons CDT Approach

- The CW CDT approach, enjoys the full backing of Team CW Industry and the Guided Weapons Tower of Excellence, and is a QinetiQ-led prime contract based on an alliance model with a thin-prime layer.

- The CW CDT is a joint planning and decision making body comprising the major CW players (across MOD and Industry) with broad involvement of the supply base.
  - **October 2008** – Four-month initialisation task to kick-start CW CDT – Interim Phase
  - **February 2009** – Eleven-month CW CDT Initial Operating Capability contract

- The core assumption is that all tasks under the QinetiQ prime will be competed unless agreed with MoD, which is in line with standard MOD policy.
Complex Weapons CDT Aims

The CW CDT provides a coherent and coordinated approach to CW R&T planning and delivery of technical capability, satisfying the needs of both MOD and UK industry by providing:

- A cohesive R&T plan
- Delivery of an EP-focussed R&T programme
- Sustainment of independent advice on CW
- Innovation
- Stability of research
- Value for defence
- An efficient and flexible contracting vehicle
- Overview of all CW R&T contracts
- Sustainment of a UK CW Industry
Complex Weapons CDT Partnering

- The CW CDT delivers the needs of MOD and Industry in the provision of CW R&T to deliver an appropriate balance of timely exploitable technology, innovation and the sustainment of sovereign capability and expert advice to support future procurements.

- It focuses and draws upon the skills of prime contractors, sub-system suppliers, SMEs and Academia to deliver world-class technology solutions that will be transitioned into outstanding and best value CW systems for MOD.
Complex Weapons CDT Partnering

- The CW CDT is not a consortium but contains a grouping of companies, known as the CW CDT partners, linked by signature to a Non Disclosure Agreement.

- The CW CDT operates with a partnering business relationship between Industry and MOD:
  - Started IOC with 21 partners
  - Increased to 24 partners in July 2009
  - Further 7 new partners in the process of joining

- Wide MOD buy-in:
  - Research Community
  - DE&S Weapons Operating Centre
  - MOD Cap – DTA, TA, AW and GM
Complex Weapons CDT Partnering

- There are no barriers to companies wishing to join the CDT supply chain – it is not a closed-shop
- Organisations (Industry and Academia) may be attracted through a variety of means including stakeholder engagement, word-of-mouth, publicity etc
- If an organisation wishes to participate in the detailed planning process (for example through participation in one or more Expert Advisory Groups) then as a first step they must become a partner (i.e. a signatory to the NDA)
- The CDT will also sponsor innovation calls through the CDE mechanism
Complex Weapons CDT R&T Strategy Document

- The strategy document draws together the research drivers, priorities and estimated budget to form the basis of the research planning prioritisation process.
- Reviewed by CW CDT Expert Advisory Groups and Joint Management Team and subsequently endorsed by CW CDT R&T Board:
  - Revised project team R&T priorities
  - R&T priorities generated by the EAGs
  - Research Goals mapping to CW domain
- This is a living-document – with an annual review that supports the DTP.
# Research Planning Output - Jointly Agreed Way Forward

### Generate detailed SoR & budget

**To enable start in early FY10/11**

<table>
<thead>
<tr>
<th>Topic</th>
<th>Status</th>
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<tbody>
<tr>
<td>Compact IM MEW</td>
<td>Effects</td>
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<td>Compact Penetrators</td>
<td>NPC</td>
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<td>SPEAR Seeker Demonstrators</td>
<td>NPC</td>
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<td>Terminal Effects and Accuracy I</td>
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<td>Integrated Weapon Operation - Studies</td>
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<td>Open Systems Architecture</td>
<td>CMI</td>
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<td>Weapon System Concepting</td>
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<td>Low Observable Weapons</td>
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**In plan – Desired FY 10/11 start**

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<th>Topic</th>
<th>Status</th>
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<td>Air to Ground Prox Fuze</td>
<td>Effects</td>
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<td>Small Antennas/AEUs</td>
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<td>Ship Integration for Lightweight Weapons</td>
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<td>Propellant Bonding</td>
<td>RPS</td>
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<td>Motor Case Lining</td>
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**Future Technology Maturation – TRL 4/5 → 6/7**

*Developing/Informing Future Options – TRL 2/3 → 4/5*

### In plan - Possible to defer

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<th>Topic</th>
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<td>Safety &amp; Arming Module</td>
<td>Effects</td>
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<td>Hardened LEEFI</td>
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<td>Compact Seeker Family</td>
<td>NPC</td>
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<td>UK Sovereign Tactical IMU</td>
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<td>NAVWAR IMU/GPS Integration</td>
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<td>Advanced Composites 1</td>
<td>RPS</td>
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<td>Thrust Control</td>
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<td>Reactive Materials</td>
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<td>MEMS Safety and Arming</td>
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<td>Ground Target Fuzing Algorithms</td>
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<td>Low Cost Dual Mode Prox Fuze</td>
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<td>Lightweight Anti Tank Lethal Package</td>
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<td>Modelling/Study - Effects Modelling Study</td>
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<td>Non-GNSS</td>
<td>NPC</td>
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<td>CW Data Link Acquisition</td>
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<td>Advanced Propulsion Techniques</td>
<td>RPS</td>
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<td>Propellant Tuning and Start-Restart Techniques</td>
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<td>IM Fragment Impact Mitigation</td>
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Success Factors

- The identification and recruitment of key players and technical specialists within the CW community, which are funded and have a specific role within the CW CDT
- Full visibility of the research-planning, tasking and contracting processes
- Coupled with an open environment, where sharing of information is respected, as is the ability for issues to be discussed openly and decisions challenged
- The Joint plan is leading to joint MOD/industry investment in the CDT programme
CW CDT Beyond IOC

- Achievements during CW CDT IOC:
  - Full engagement of stakeholders from MOD and industry
  - Full CW CDT governance exercised
  - Research tasking is now being delivered
  - MOD Cap now fully embedded with CDT
  - R&T Strategy Document now released
  - Plan for CW research that has been jointly agreed and endorsed

- Now seeking to transition to a continuous improvement stage – demonstrating flexibility and agility
- In our plans we aspire to expand the scope of the CW CDT to a Weapons Technology Centre
Summary

- The CW CDT vision will be achieved by identifying and supporting rapid development and technology exploitation whilst sustaining critical sovereign skills.
- The CW CDT demonstrates its partnering approach by utilising a responsive and adaptive virtual “centre” that embraces an integrated team of MOD, Academia, SMEs, Primes and Technology Innovators.
- This approach complements the CW equipment pipeline approach providing a comprehensive package that will maximise the military capability from a sustainable UK industry base.
- By connecting the Research Community and company PV funding, the CW CDT provides a seamless process to exploit the best ideas into fielded systems in the future and ‘bridge the valley of death’ with a coherent R&T strategy and plan for CW research.
FY10/11 Delivery Plan

STATUS:
- Many elements of FY09/10 programme ongoing - high level of commitment into FY10/11
- Final budget figure for FY10/11 not yet available
- Top level Delivery Plan for FY10/11 produced in consultation with key MOD stakeholders
- Prioritised to allow programme to be matched to available budget
- CW Elements agreed & prioritised via the CW CDT
- Plan forms basis for domain plans in new Dstl Programmes Office structure
FY10/11 Delivery Plan

Priorities/ Thrusts:

• Modularity/Open architectures
• Networked Weapons
• Directed Energy Weapons
• Tuneable and affordable precision effects
• Countering Difficult Air Targets
• Weapons Integration
FY10/11 Delivery Plan

Potential new programmes for FY10/11 include:

- Weapons Integration
- Countering Difficult Air Targets
  - Including Laser DEW, conventional effectors & sensors
- CW Programmes via CW CDT (see CDT presentation)
- Themed innovation calls via CDE, CW CDT & MCM ITP
- Open innovation calls via CDE
Summary
Summary

Programme Drivers

- Support to current Ops
- Exploitation
- Innovation
- Engagement with wider supplier base
- Sustaining sovereign capabilities
- Duty of Care and Safety
- Supporting Through Life Capability Management
Summary

Planning & Delivery
- Coordinated Planning:
  - Within MOD
  - With suppliers
- Partnerships and shared destiny
- Strategic approach to International Collaboration
- Competition

Organisation
- DTIC Closes 31st March 2010
- New Dstl Programmes Office established 1st April 2010
Key Contacts/Appointments

MOD Centre
- D S&T Strat (2*) – Prof Phil Sutton
- Strategy Lead (Wpns) – Chris Leach

Dstl Programmes Office
- Hd Dstl Programmes Office (2*) – Jonathan Lyle
- Domain Lead Weapons – Gina Lindsley

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Questions/ Discussion