DEFENCE R&D DÉFENSE

S&T Activities in Support of the Canadian Small Arms Replacement Program

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Recherche et développement pour la défense Canada
Defence Research and Development Canada
Canada

Canadian Forces Soldier System Vision

The Soldier as an integrated weapons platform: a "System of Systems"

Environmental Clothing System

Mobility Systems

Ballistic Protection System

Head Borne Systems

Weapon Systems

Personal Network

Battle Management Systems

Comms Systems

Navigation Systems

Power Sources

Sensors Systems

UGS Micro-UAV Personal

Small Arms Replacement Program

- Acquisition valued at over $1.0 B
- Aim:
  - To ***replace*** or ***modernize*** CF small arms inventory and associated ammunition and fire control systems
  - To deliver a modern, networked, integrated direct fire, multi-effect, portable anti-personnel and anti-material capability that includes weapons, fire control, munitions, training systems and logistic support for the CF in the 2012 to 2022 period (CF SRB 21 Sept 2007)
- Timeline:
  - Project 1 – Acquisition of pistols, Canadian Ranger's rifle, Weapon sights, Weapon accessories
  - Project 2 – Acquisition of a Personal Defence Weapon (PDW), Tactical Shotgun, Grenade Launcher System, Naval boarding party weapons, breaching systems and hand grenades; and
  - Project 3 – Modernization / replacement of the CF Individual Combat Weapon capability

Major S&T Activities Supporting Small Arms Replacement Program

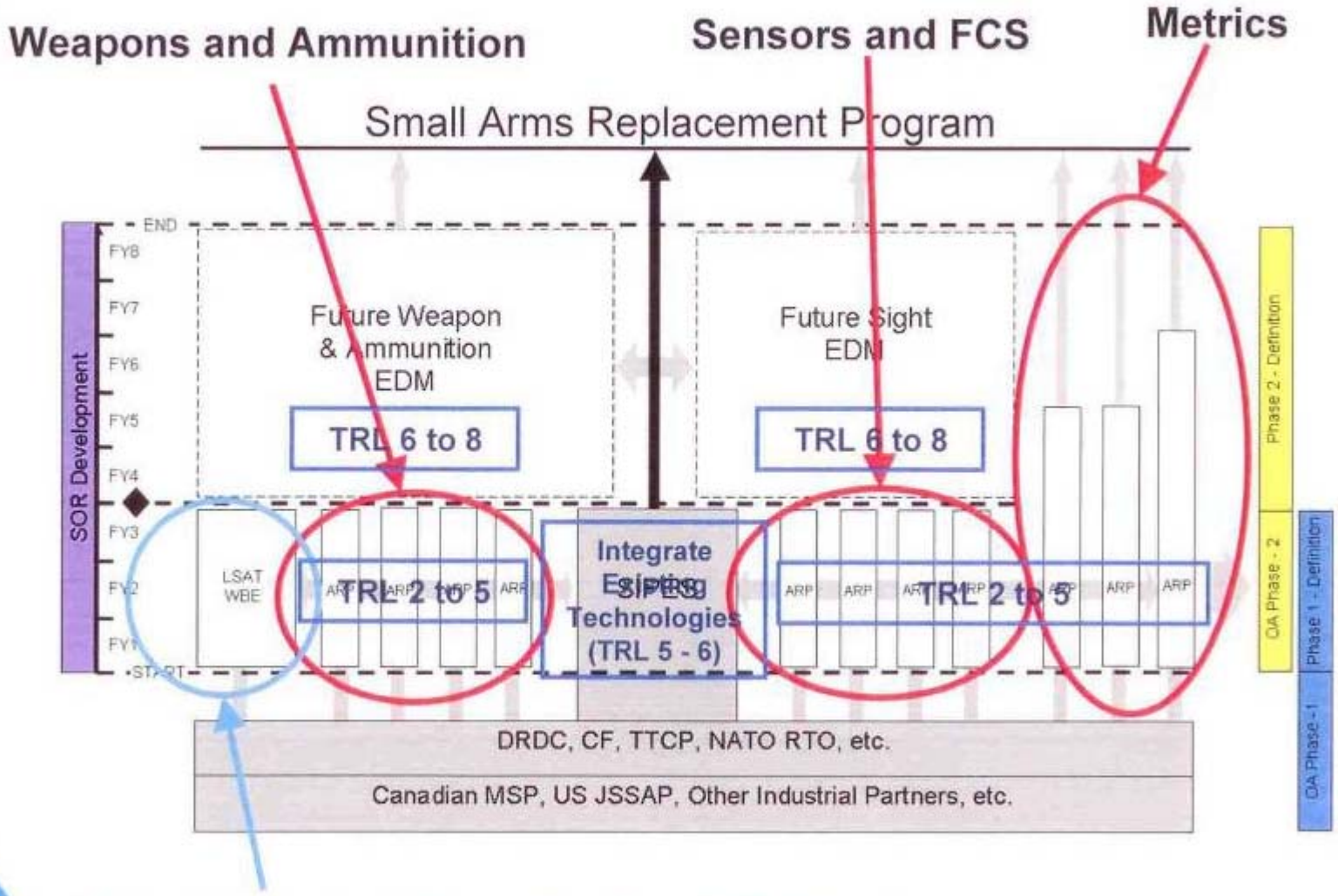
Statement of Operational Requirements (SOR) Development Effort

- Objectives
  - Develop science-based operational requirements for CF man portable future direct fire capability (FDFC) as part of the Small Arms Replacement Program
- Components
  - Soldier Integrated Precision Effects System (SIPES) Technology Demonstration Project to explore system integration issues (***financed***)
  - Applied Research Projects (ARP) to build up knowledge and technology base
  - Engineering Development Models (EDM) to integrate the results of SIPES, ARP, and SSTRM in TRL 8 level systems

Soldier Systems Technology Road Map (SSTRM)

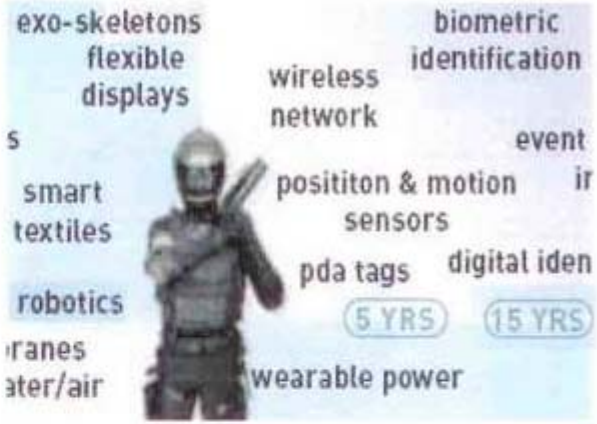
- Objectives
  - To develop a comprehensive technology roadmap (TRM) that will support the Canadian Forces soldier modernization effort using Industry Canada TRM framework: a fair and transparent process open to all stakeholders (***financed***)
  - Much larger than soldier weapons

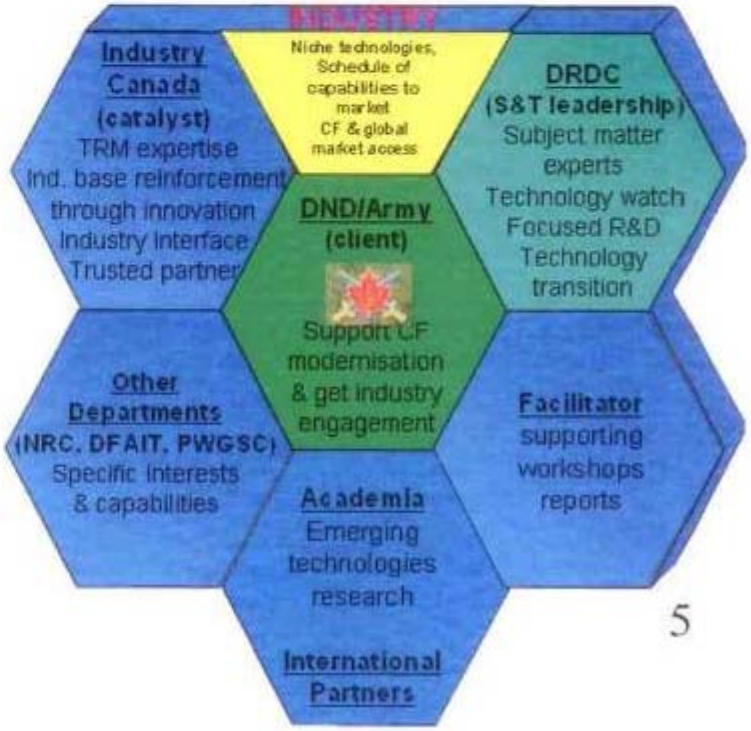
Small Arms Replacement Program
SOR Development Effort



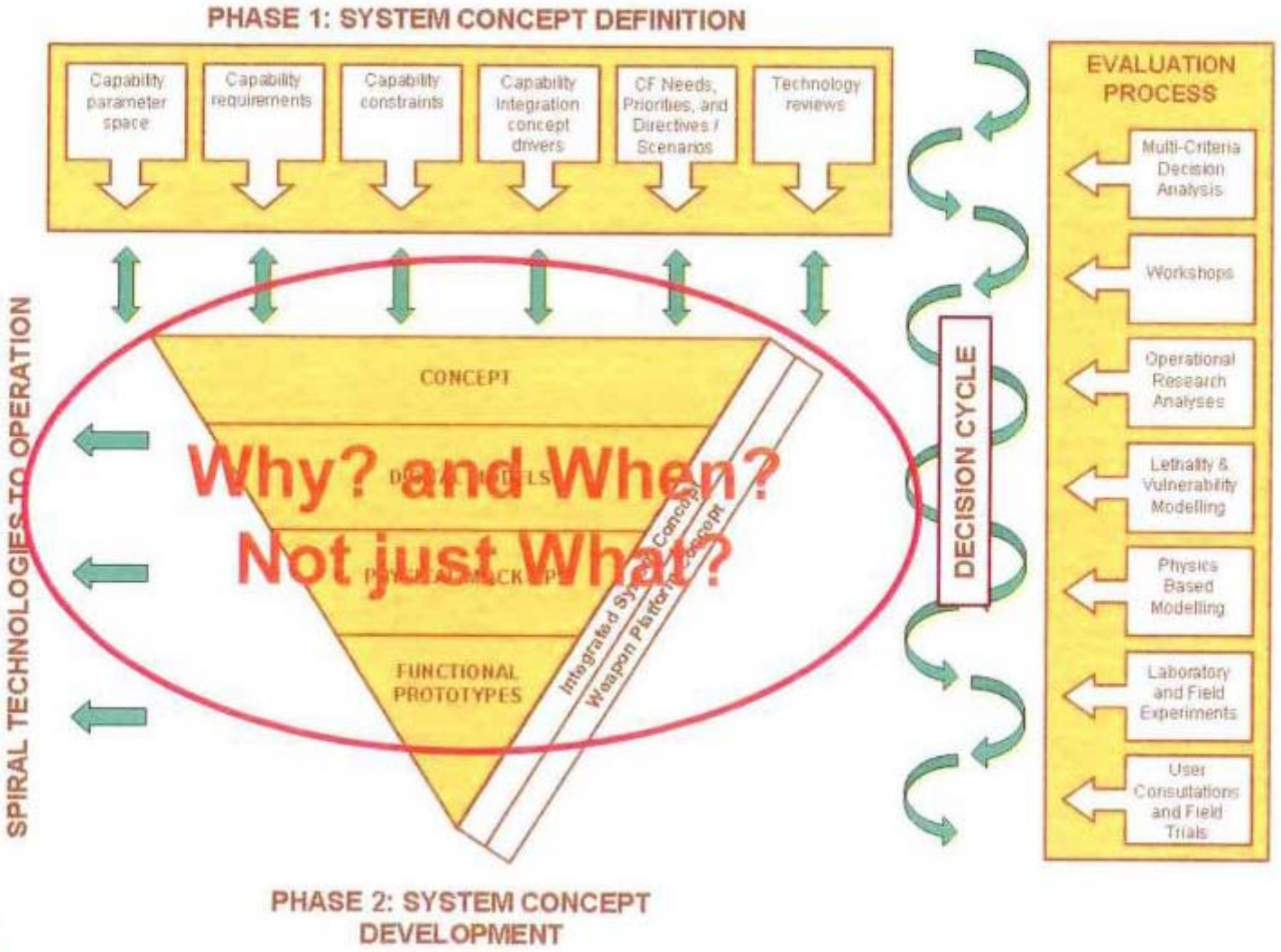
Soldier Systems Technology Roadmap Project

- **Government Role**
  - To provide Industry and Academia with an equal opportunity to be aware, understand and discuss future DND needs
- **Industry/Academia Role**
  - To provide DND insight on novel technologies maturing in 3-15 year and leading to potential important increases in soldier capabilities
  - Industry plays an integral role in the TRM process
- **Soldier Systems TRM Process**
  - Visioning and technical workshops
    - 6 including lethal and non-lethal weapons
  - Novel Collaboration Tool (ICee)
    - Innovation Collaborative Exchange Environment
    - Public/Password controlled data base / Wiki
      - "http://soldiersystems.collaboration.gc.ca"
  - R&D projects aligned with identified priorities

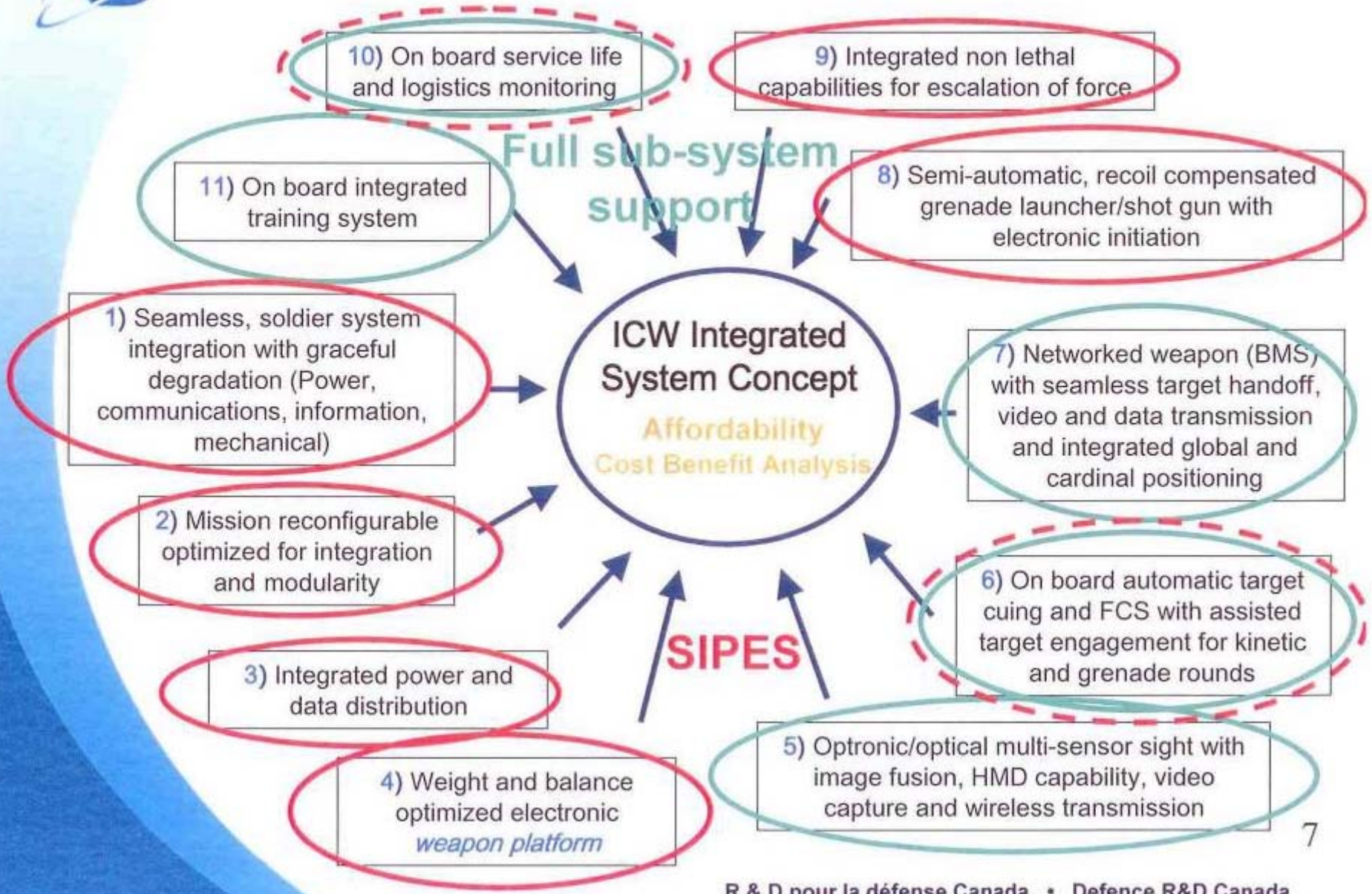




SIPES Technical Strategy

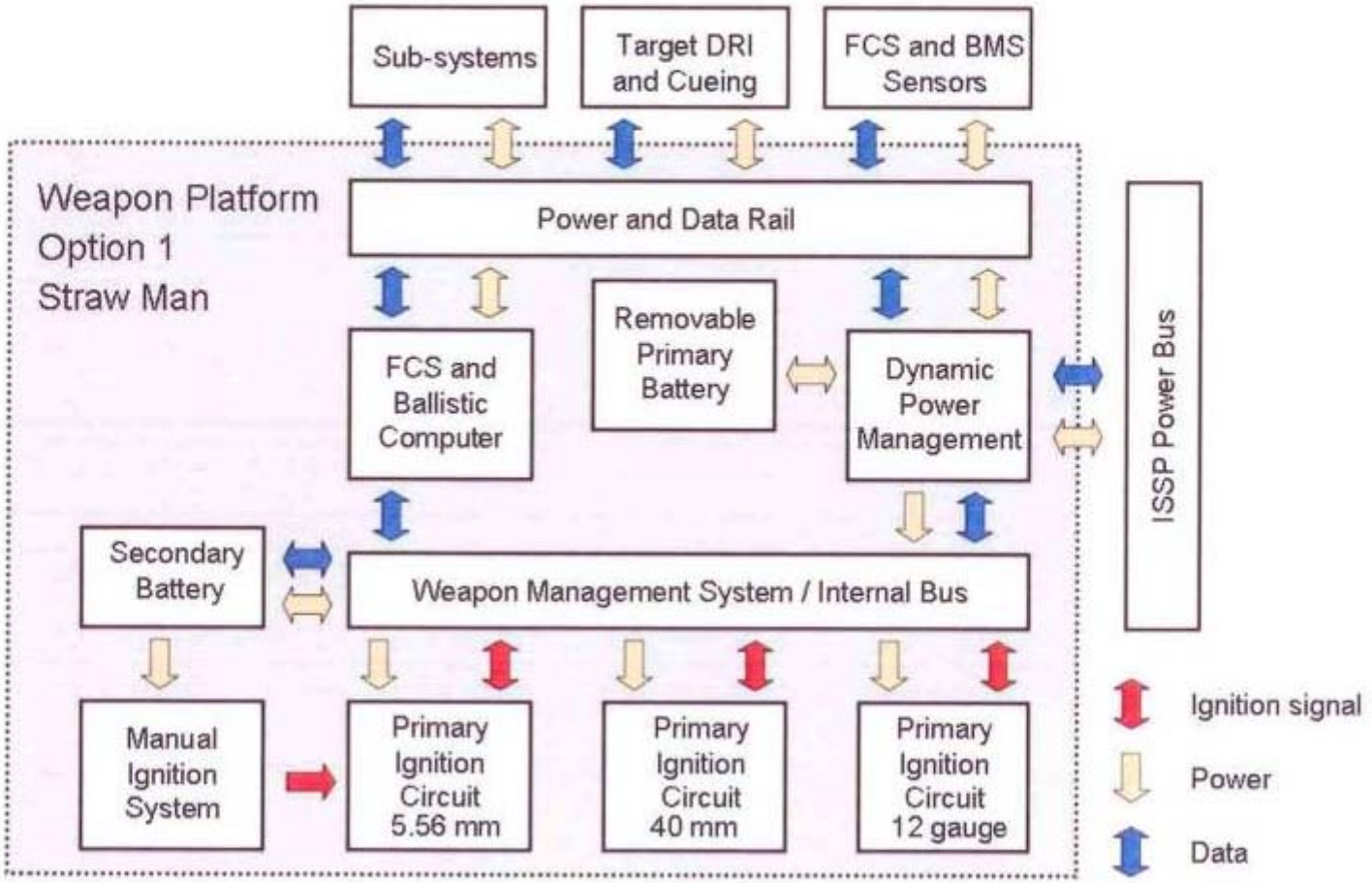


SIPES ICW Integrated Weapon System Concept



SIPES ICW Platform Concept

Electrical and Data System Architecture



SIPES ICW Platform Concept

Operational Objectives

- Increased mission effectiveness through
  - Weapon configuration flexibility (mission configurable)
  - Integrated escalation of force
  - Soldier networking
  - Optimized usage of electrical power
- Increased lethality through
  - Increased accuracy
  - Increased fragmenting round capability
- Increased usability through
  - reducing total carriage
  - optimizing weapon system handling

A weapon platform with the capability to maximize the use of future technological innovations

Overview of SIPES Plan

Primed by Colt Canada

- Canadian Partners: GD-OTS Canada and HSI Inc
- Potential International Partners: Caseless Technology AG, Metal Storm

Task Description	FY 1				FY 2				FY 3				FY 4				FY 5			
	Apr 09-Mar 10				Apr 10-Mar 11				Apr 11-Mar 12				Apr 12-Mar 13				Apr 13-Mar 14			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Phase 1 - System Concept Definition																				
Phase 2 - System Concept Development																				
Preliminary Design of Weapon Platform																				
Characterization of key enabling technologies																				
Conceptual design of configurations																				
Human factors analyses																				
Electronic achitecture																				
Sub-system integration																				
Prototype Design and Analysis																				
Prototype Build and Testing																				
Fabrication of prototypes																				
Unmanned testing and limited man certification																				
Capability demonstrations																				
Weapon power bus / soldier system connectivity																				
ATC / ATE functionality																				
LSAT CL ammunition (electronic ignition)																				

Selected Thoughts from Phase 1 of SIPES

The Issue of Weight and Balance

- Weight constraints
  - Total carriage
  - Weapon system effectiveness
- Total Carriage
  - Average soldier carries 10.8 kg ***over*** maximum allowable (26.2 kg)
  - Weapon and ammunition accounts for 24% of total weight (8.9 kg)
- Weapon System Effectiveness
  - NATO RTO studies indicate that
    - ***5.35*** kg is completely acceptable
    - ***6.83*** kg is somewhat acceptable depending on CG
  - Present weight of C7 + 2 Mags + C79 is ***5.09*** kg
  - Present weight of C7 + 2 Mags + C79 + M203 + Ammo is ***7.42*** kg
- Weight is an issue for a future weapon system with increased capability

The Argument for Electronic Ignition

- Kinetic Round
  - Increased control of automatic/burst fire with more rounds on the target
  - Increased accuracy under all conditions with automatic target cuing and assisted target engagement
- Fragmenting Round
  - More and faster delivery of rounds on target
    - With minimum weight penalty (innovative technological approach)
    - Without taking eyes off target
  - Firing from behind cover through seamless connectivity between launcher and FCS
- System
  - Enhances level of system integration
  - Provides flexibility in weapon configuration
  - Provides potential technical solutions for caseless ammunition
    - Chamber sealing (firing pin)
    - Cook-off (temperature sensors)
    - Light percussion

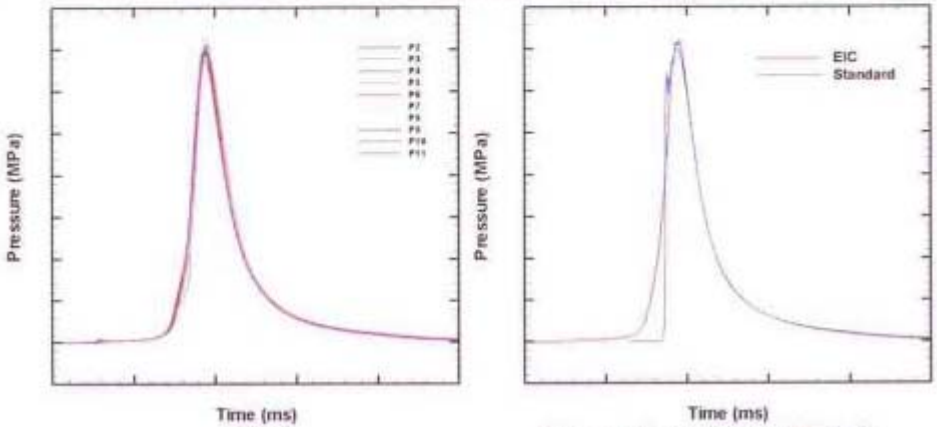
Characterization of Electronically initiated caseless ammunition

Objective

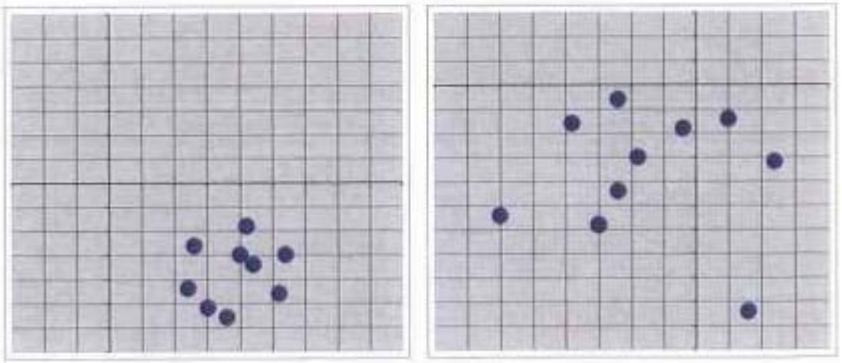
- Determine whether available electronically initiated caseless (EIC) ammunition technology is acceptable for a weapon platform prototype
- Evaluate key parameters applicable to weapon system design – chamber pressure profile, lock time, action time, accuracy, cook-off, …

Results for non-telescoped rounds

- Muzzle velocity variation: $\sigma_{EIC}/\sigma_{Stnd} = 0.7$
- Consistency: $\sigma_{EIC}/\sigma_{Stnd} = 0.5$
- Lock time + action time: $t_{EIC}/t_{Stnd} = 0.45$
- Still need to evaluate telescoped ammunition



EIC Standard and EIC
Chamber Pressure Profile



EIC Standard
Dispersion at 80 m

Automatic Target Cueing (ATC) and Assisted Target Engagement (ATE)

Objective

- Reduce the effect of soldier stress on shot accuracy through assisting the soldier to fire at the optimal time

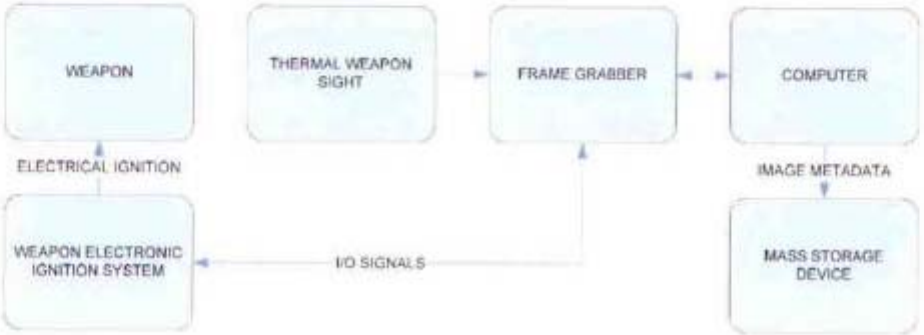
Concept Exploration

- Preliminary concept demonstration
  - VEC-91 rifle, MOTS TWS, frame-grabbing and thermal target
- ATC-ATE Mod 1
  - Purpose designed TWS with no FCS to be demonstrated on SIPES weapon platform
- ATC-ATE Mod 2
  - Addition of FCS

AN/PAS-13B

AN/PAS-13C

VEC-91

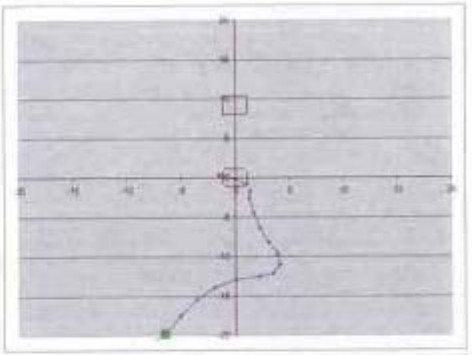


Assisted Target Engagement Concept Analysis

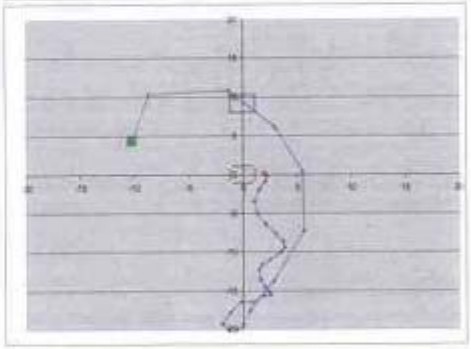
Objective

- Characterize rifle slew rate, shot delay and general aiming behavior of soldiers to provide design and analysis input for the ATE concept
- Data analyzed was thru sight video from NATO RTO trials using US Marines (significant Canadian participation)

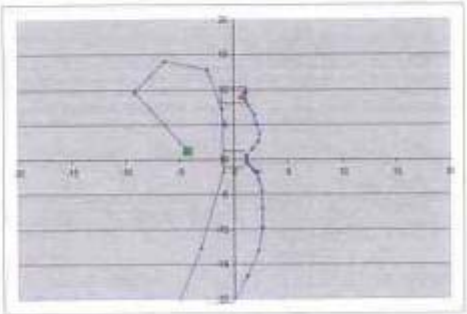
Range of 25 m



Shot 1



Shot 2



Shot 3

Characterization of Bullet Lethality

Present Effort

- Development of a methodology to experimentally characterize the flight dynamics of bullets
- Development of a methodology to experimentally evaluate the terminal effect of bullets on human surrogates
- Development of a methodology to numerically model the terminal effect of bullets on human surrogates

Canadian version of work done by Joint Services Wound Ballistics IPT

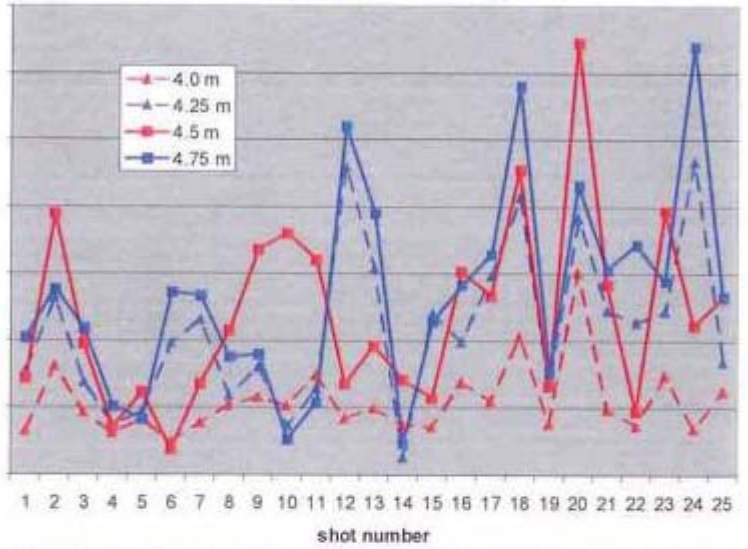
A Methodology to Characterize Bullet Flight Dynamics

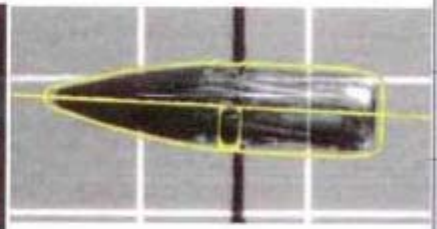
Objective

- Develop a measurement methodology and perform preliminary characterization of the the yaw behavior of C77 rounds fired under various conditions

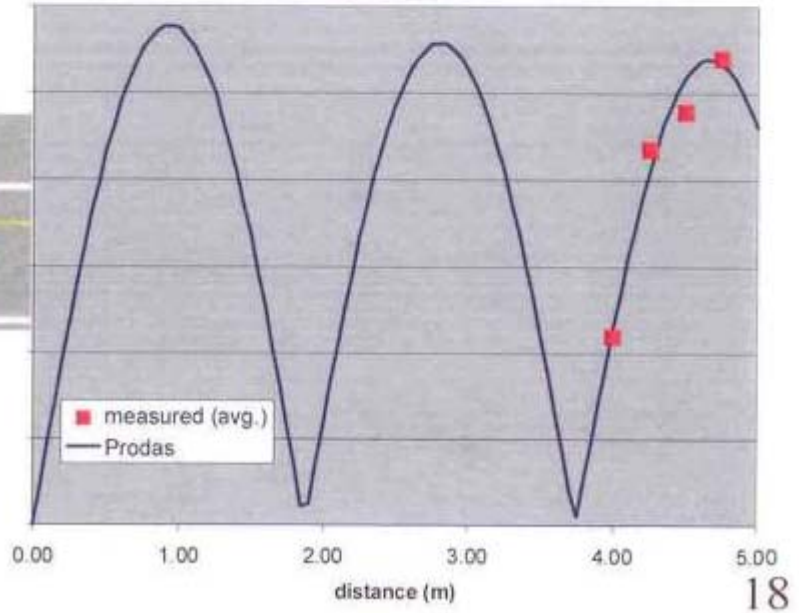
Observations

- Significant round-to-round variations
- Cyclical variation with distance confirmed
- Yaw dependence on barrel temperature
- Yaw dependence on barrel type (Mann barrel)





Two orthogonal camera stations



Summary

- The Canadian small arms replacement program is being supported by two major S&T initiatives
  - SOR Development Effort, government directed
  - Soldier Systems Technology Roadmap, industry focused

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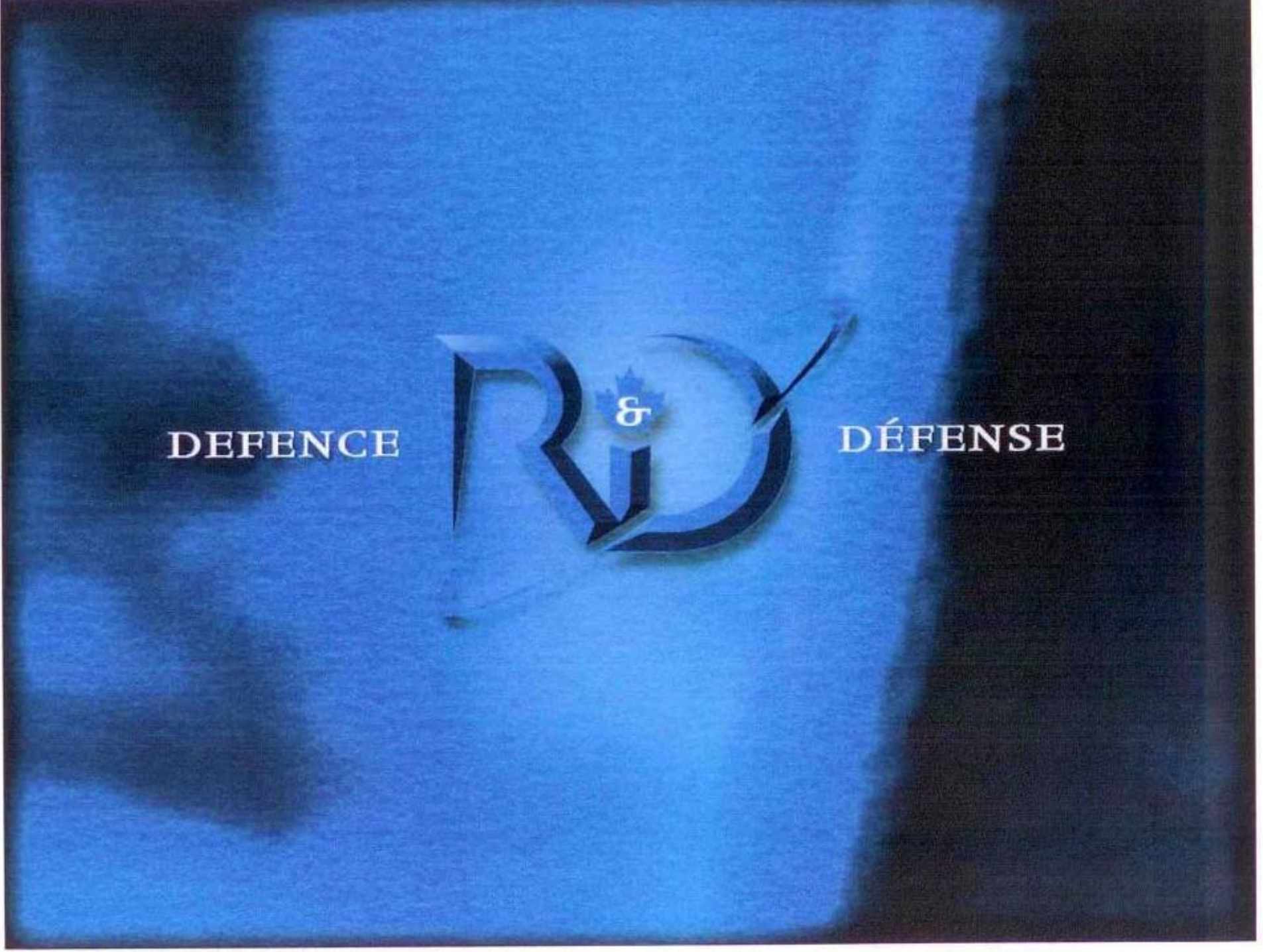
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