C2 Challenges for Modelling and Simulation

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Outline

- M&S and C2

- Mismatch hypothesis

- Analysis of C2 theory for requirements

- Summary

C2 and Simulation

- Use of simulation to assist operational commanders.

- It seems like a "no brainer" – simulation should be useful

  – But …

- There are few examples of successful applications

  – And they are often used in simplest configuration or by a very few very motivated individuals.

- WHY

  – There is a mis-match between products and user requirements

Simulation to C2 Mismatch Hypothesis

- Military Commanders are the product of a long-term and intensive system that filters for professionals who can decisively handle complex stressful situations.

    - Wide range of experience

    - Extensive engrained doctrine

- For new tools to be accepted they must provide added value – which means that they must provide something the user cannot do themselves, or do it for lower cost in resources.

- Simulations which fit to C2 timescales often are too simplistic to give added value.

- Complex simulations which might give added value take too long to use (setup or analyze results).
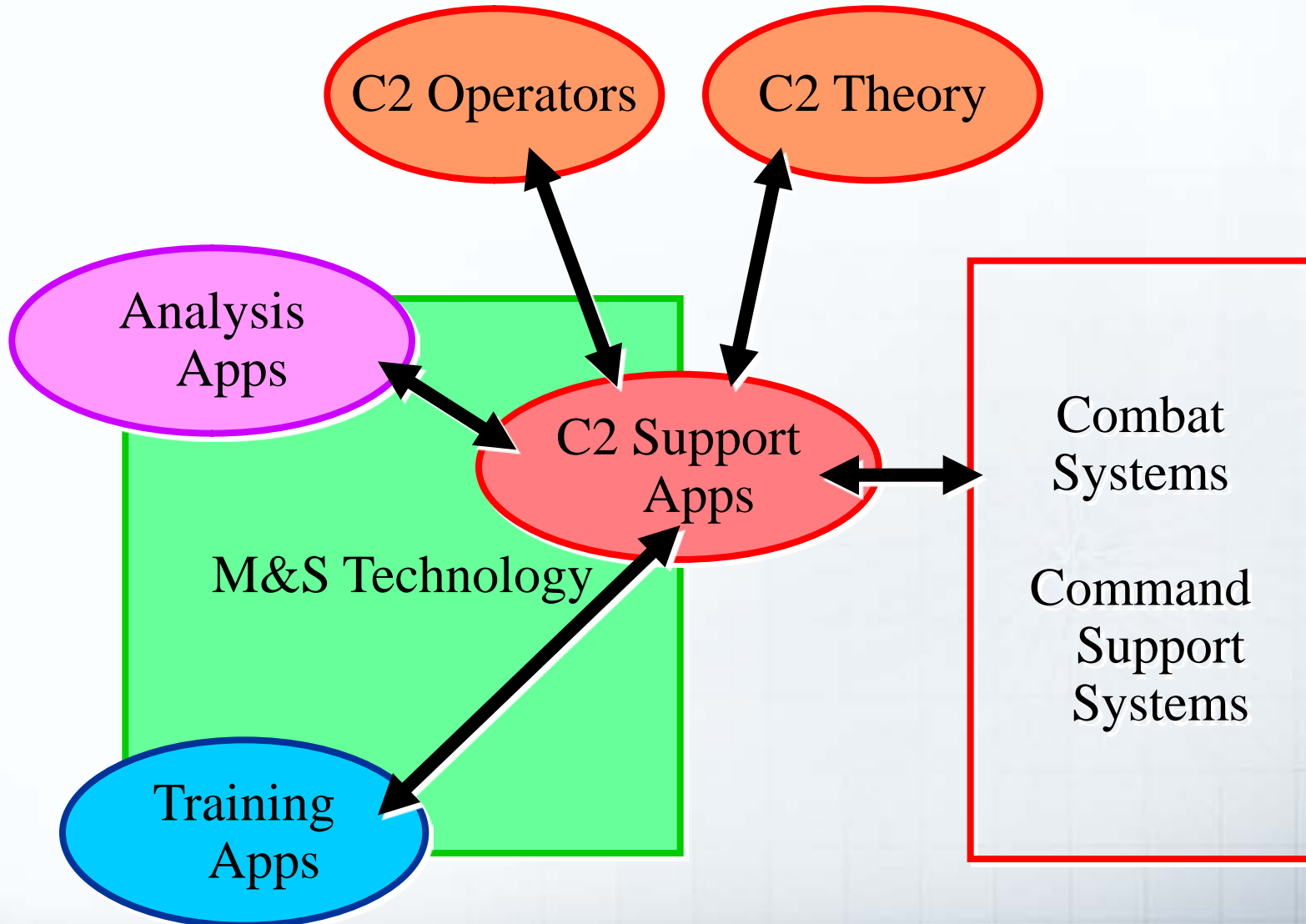
How can we address the mismatch?

- Analysis of C2 theory
  - Command and control is (for now) a human-centric activity
  - System analysis must include the human as an integral part
  - Determine where and when parts of the system become overloaded or inefficient
  - Target solutions at those parts of the process
- Derivation of C2 support requirements
  - Determination of M&S technology gaps

Initial C2 Theory Analysis

1. Rational/Analytic vs Naturalistic Decision Making

2. Centralized vs Netcentric C2 Organizations

3. Asymmetric / Effects Based Warfare

4. Joint / Coalition / Comprehensive

Rational vs Naturalistic Decision-Making Tool Requirements

- Both rational and naturalistic processes must be supported
  - Fit to decision-making timescales
  - Allow exploratory analysis (iterative)
  - Give intuitively understandable (and credible) results
  - Support identifying decision points
- Wide range of experience required for both processes
  - Incorporate experiential knowledge as developed
- Facilitate the intuitive interaction of human and digital world
- Facilitate the transfer of experiential knowledge from in-theatre personnel to the rest of the C2 community

Centralization vs the Edge
Tool Requirements

- Primarily about dissemination and understanding

- Support to real-time monitoring of battle-space in the context of the intent.

- Provision of pre-planned or expected reactions of battlespace to events

- So integration of tools with combat management systems

- Replanning tool response times to match naturalistic decision-making timescales

- Prediction of macro-effects resulting from micro-actions

- Support to the communication/collaborative development of plans/intentions – optimal use of available bandwidth.

Assymetric Complexity Tool Requirements

- Understanding of social, cultural, economic, military, diplomatic effects of operations

- Tools to support decision-maker understanding of the full spectrum of effects

  - Social, cultural, economic models of environment

  - Interoperability of models allowing federated use of a suite of tools.

- High tool complexity requiring intuitive configuration control and management.

  - Some level of reproducibility of results

Comprehensive Operations Tool Requirements

- Wide range of security, inter-relationship, and trust levels.

- Wide range of organizational structures and responsibilities

- Share-ability of tools and/or results
  - Common/standard formats

- Tools to support the management of loose C2 organizations.
  - Represent variability in behaviour, reporting periods …
  - Representation of non-military, non-hierarchical organizations
  - Represent non-military objectives, and generate non-military measures of effectiveness

	C2 requirement Theme	Simulation Research
	Table 1: General C2 themes and supporting Simulation research activities	
1	the need for intuitive interfaces that allow commanders to translate their ideas to a digital format.	Tablets and surface computing
2	the need for analysis generation times to match commander cognitive processing cycles.	Multiple Trajectory modeling Parallel processing, cloud computing Distributed simulation
3	the need to capture experiential data as it becomes available in a digital format that is usable by both on-scene commanders and those training for deployment.	Lesson learned databases
4	the need to expand mission critical data collection, storage and analysis to include cultural, economic and societal information; and the ability for other digitally based tools to access the data.	Crowd modeling Social and economic simulations
5	the need for visualization tools that enhance commanders understanding of large amounts of data and information. These tools need to be matched to the commander's mental models.	Visual analytics and Geographic Information Systems.
6	the need for common tools, or tools that can provide equivalent outputs from equivalent inputs, across C2 structures and multiple organizations.	Verification, Validation and Accreditation (VVA) processes.
7	the need for interoperability between tools and operational C2 systems	CBML MSDL Distributed Simulation
8	The need to transfer experiential knowledge to other current and incoming commanders and staff	Virtual Worlds and serious gaming
9	The need for commanders to understand why a change in input parameters makes a change in the output.	Multiple trajectory modeling Simulation replay systems

Summary

Four complementary research programs are required

1. The development of C2 process models and understanding of the impact of a variety of organizational and cultural factors on them

2. HF study of operational C2 decision centres to develop metrics on ergonomic and cognitive parameters

3. The development of intuitive and usable interfaces between human and digital worlds

4. Development of practical simulations of complex military-socio-economic processes

Conclusion

- Building M&S infrastructure to meet training (and analytic) requirements will not get us to C2 support applications

  – Even though those applications are likely to need many of those requirements as well.

- The C2 community must figure out their requirements, and provide performance metrics to the M&S community.

- While awaiting those performance metrics there are areas that need attention

  – Usable simulation initialization, output visualization interfaces.

  – Scalability of simulation

  – Real-time VVA – operator trust, understanding of simulation fidelity and constraints.

  – Integrated military-socio-economic simulations

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