

Programme

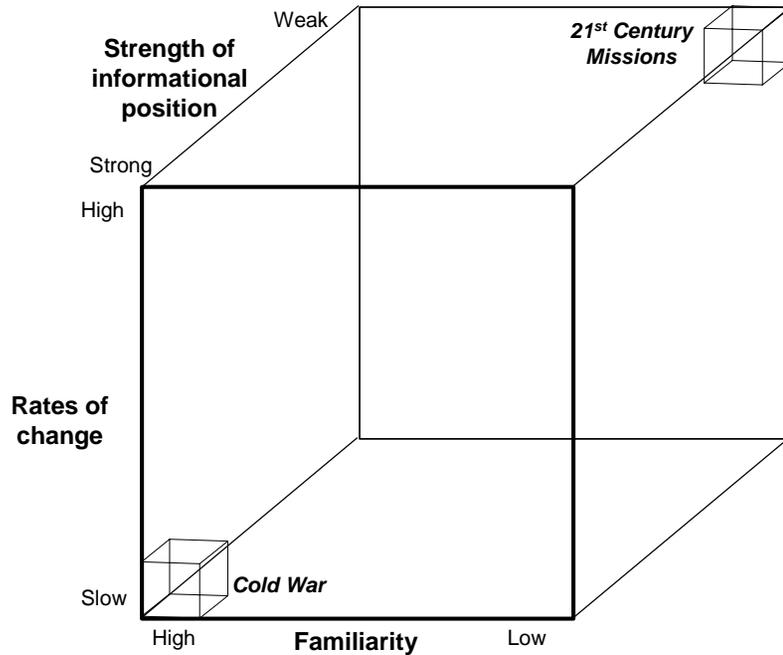
- Introduction
- Parameters for C2 Configurations
- The Vignettes
- Experimental Results
- Summary/Conclusions

Introduction

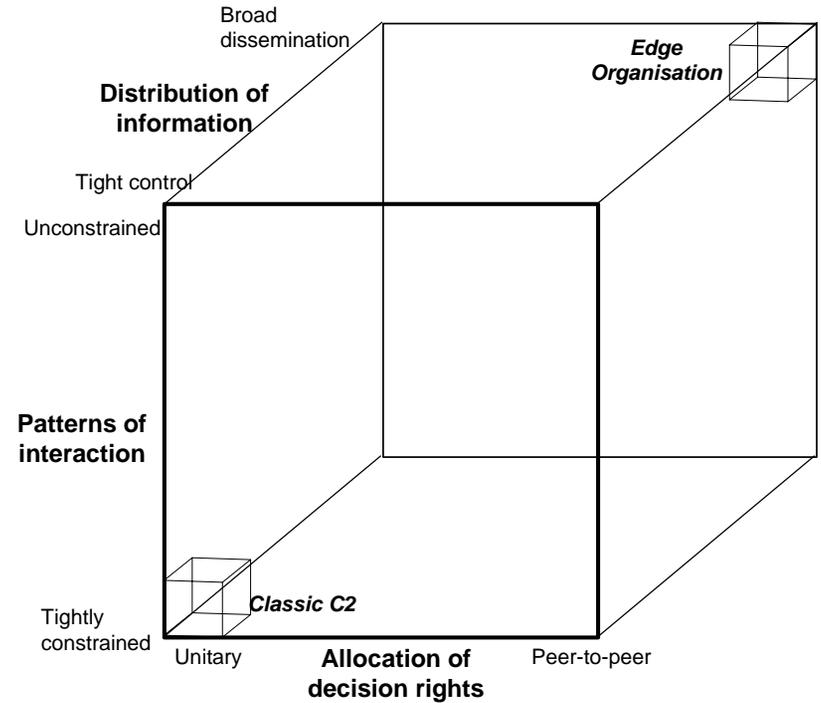
Characterisation as three sets of attributes

- Attributes of the operational environment
 - Difficult to influence (e.g. Terrain, rates of change, familiarity and predictability)
 - Amenable to influence (e.g. Boundaries, value-systems)
- Organisational attributes and building blocks
 - Capability components (e.g. equipments, doctrine, personnel)
- Command and control attributes
 - Levers (e.g. Success measures, intent, feedback mechanisms)

Setting the context for the simulations



CCRP C2 Problem Space



CCRP C2 Organisation Space

C2 configurations

Simulation parameterisation of C2 configurations

- Ownership and responsibility (e.g. Force ORBAT structure)
- Authority for actions (e.g. Command freedoms and decision rights)
- Re-assign-ability at run-time (e.g. re-allocation of support units)
- Internal information sharing (e.g. own force status reporting structures)
- Planning horizons and forward projection (e.g. cyclic vs continuous)
- Logistics C2 structures (e.g. demand-led or supply-determined)
- ISTAR architectures (e.g. distribution and processing of sensor-derived info)

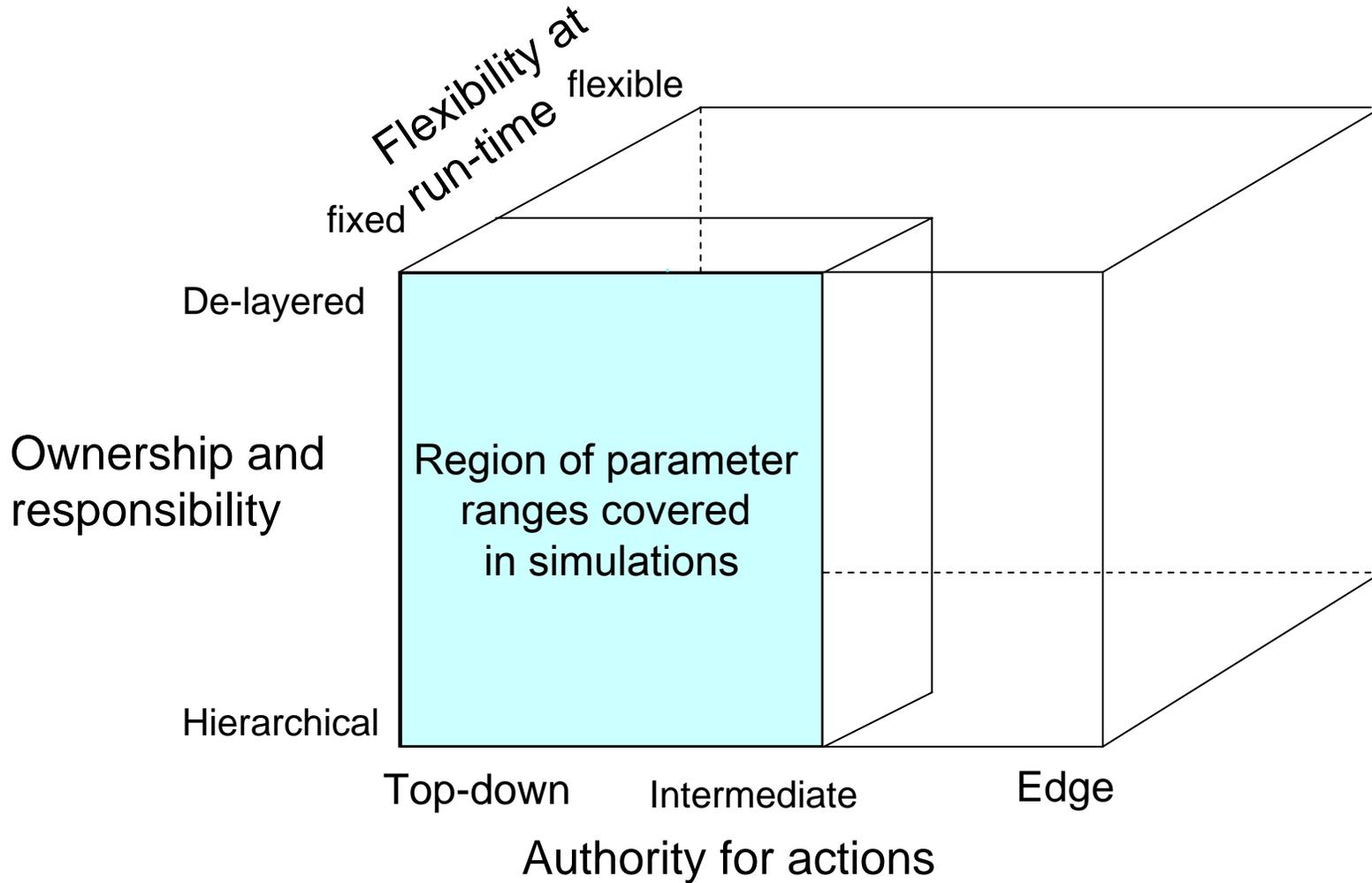
Concepts and definitions

Parameters to define different C2 configurations

Independent variables relate to:

- Ownership and responsibility
 - (e.g. Force ORBAT structure) → Number of layers
- Authority for actions
 - (e.g. Command freedoms and decision rights) → degree of autonomy
- Re-assign-ability at run-time
 - (e.g. re-allocation of support units) → asset flexibility

C2 configuration space covered in the simulations

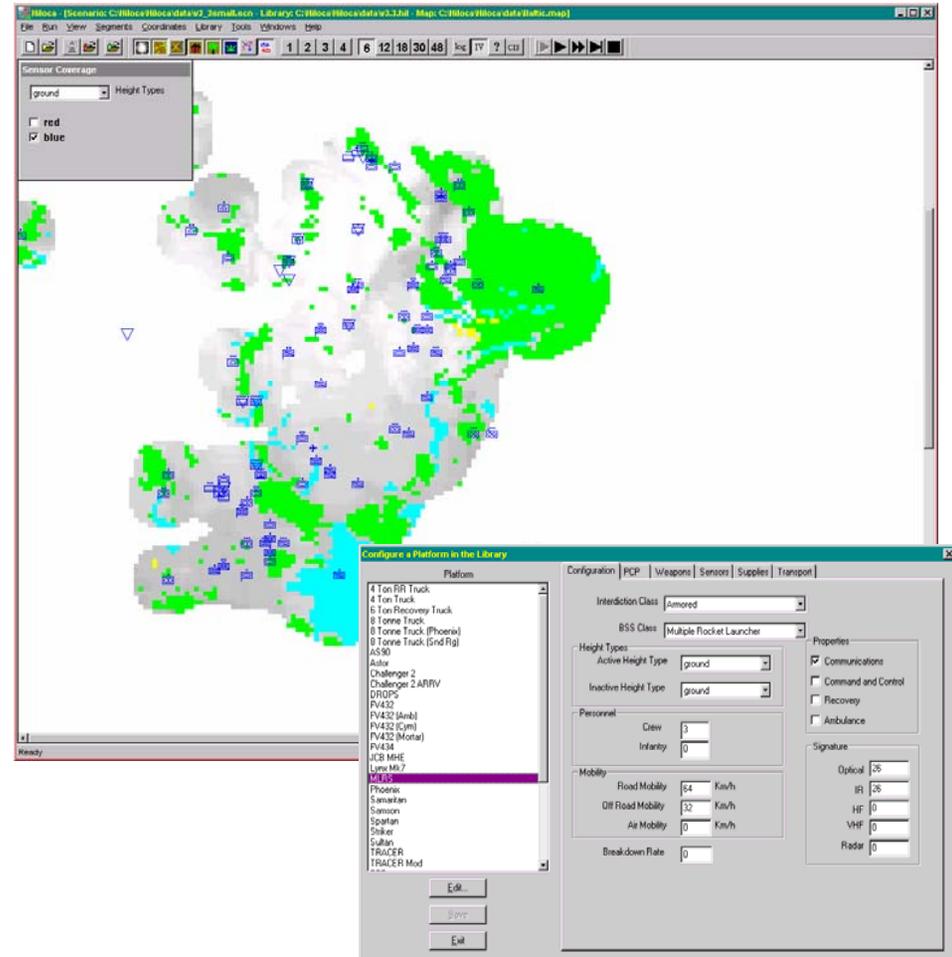


Simulations to investigate three different configurations

C2 configuration	Force Structure (Command Layers)	Assignment of support Units	Command Freedoms
Top down hierarchy (1)	4	None	Low
Intermediate (2)	3	Long range artillery	Medium
Edge (3)	2	Long range artillery, Manoeuvre Units, AH	High

HiLOCA: High Level Operations model using Command Agents & Cellular Automata

- Dynamic analysis of C2I2 operational effectiveness
- Explicit representation of C2I2 structures, interactions, feed-back and HQ functions
- User-configured building blocks for concept development
- System-of-systems studies



HiLOCA outputs

- High level combat effectiveness measures such as casualties, force tempo and losses.
- Logistics usage and deficits (e.g. demand profiles, shortfalls)
- Picture compilation metrics (e.g. accuracy, completeness, consistency)
- Command decisions and timings
- Sensor reports and sensor movements
- Own force status messages (e.g. LOCSTATS and SITREPS)
- Own force movements – all units over time

Three sets of parameters as independent variables

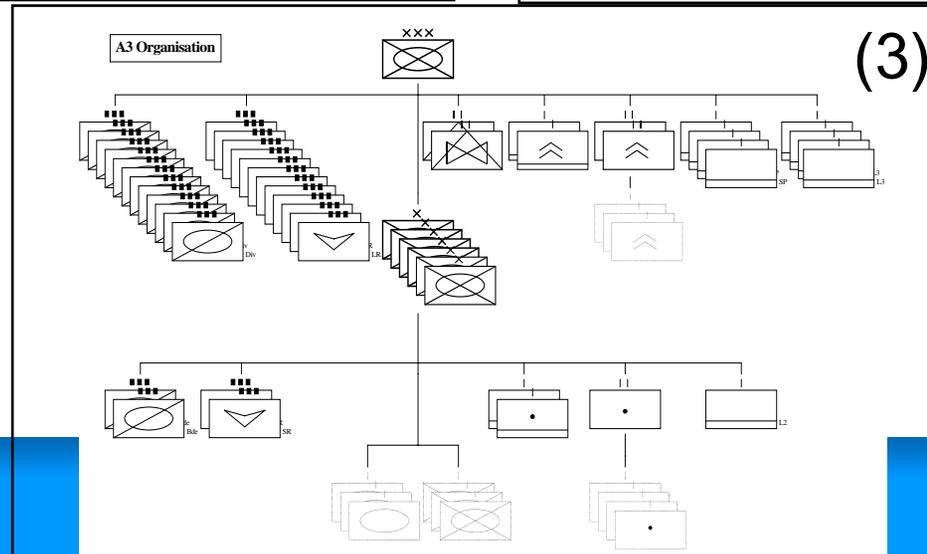
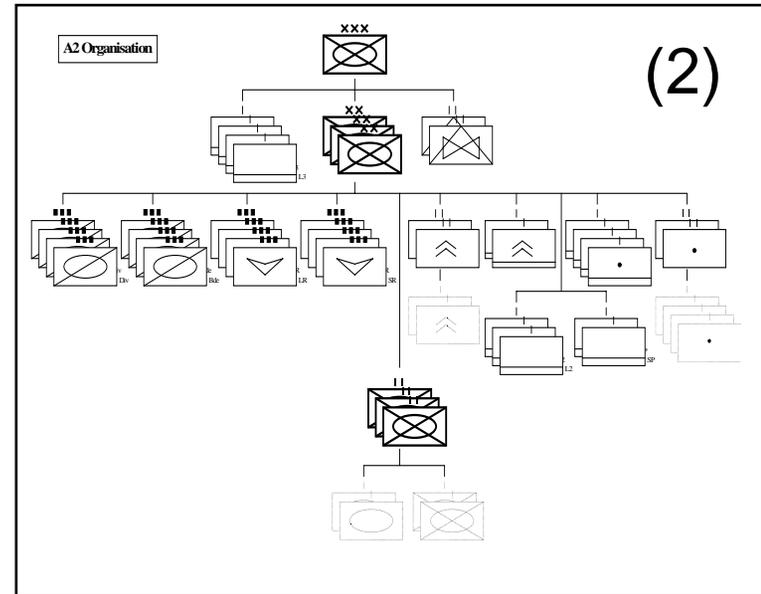
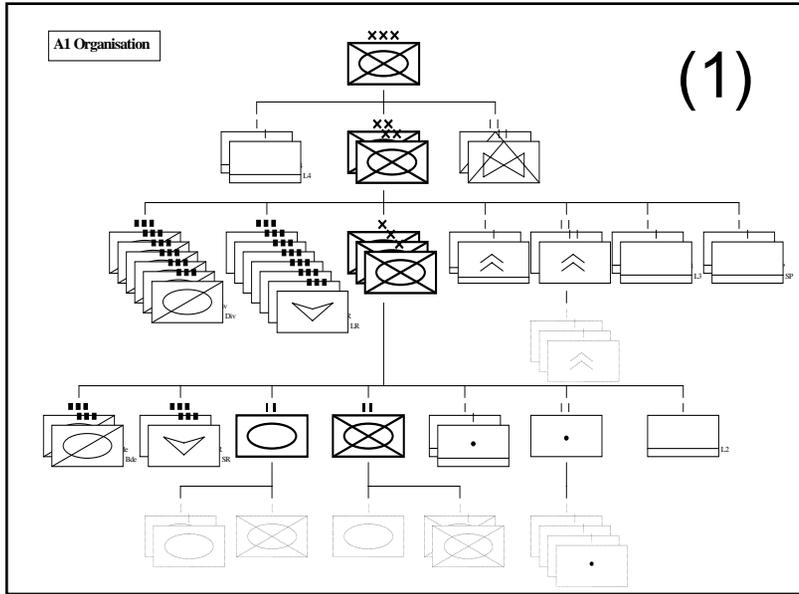
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Ownership and Responsibility

Number of C2 nodes at command levels

	1: Top-down	2:Intermediate	3: Edge
XXX	1	1	1
XX	2	3	-
X	6	-	4+2
II	12	9	-
combat elements	36	36	36

Force structures: (1) top-down (2) intermediate (3) Edge (de-layered)



Values for command-decision autonomy

	1: Top-down	2: Intermediate	3: Edge
V	50%	40%	30%
α	40%	50%	60%
Crit	75%	40%	20%

$$\text{Crit} = V(1 - \alpha)/\alpha$$

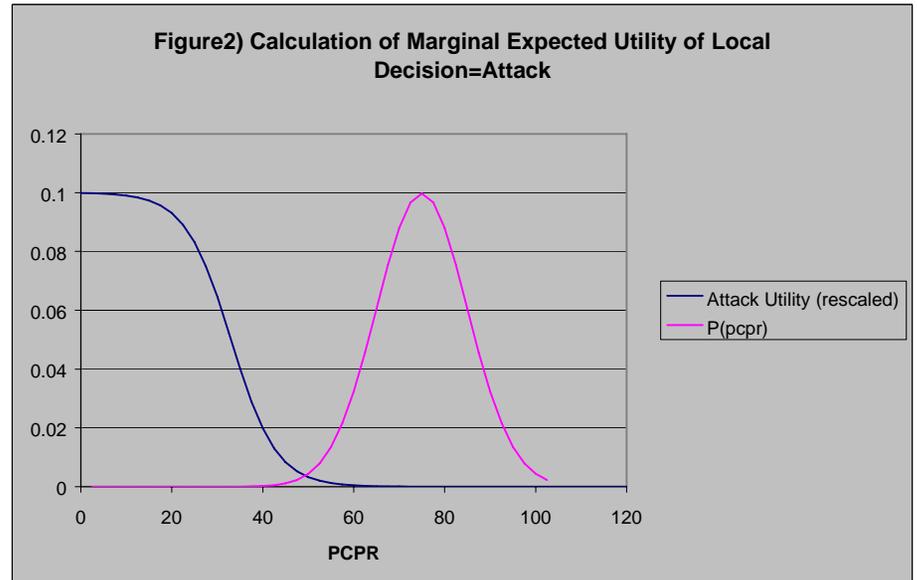
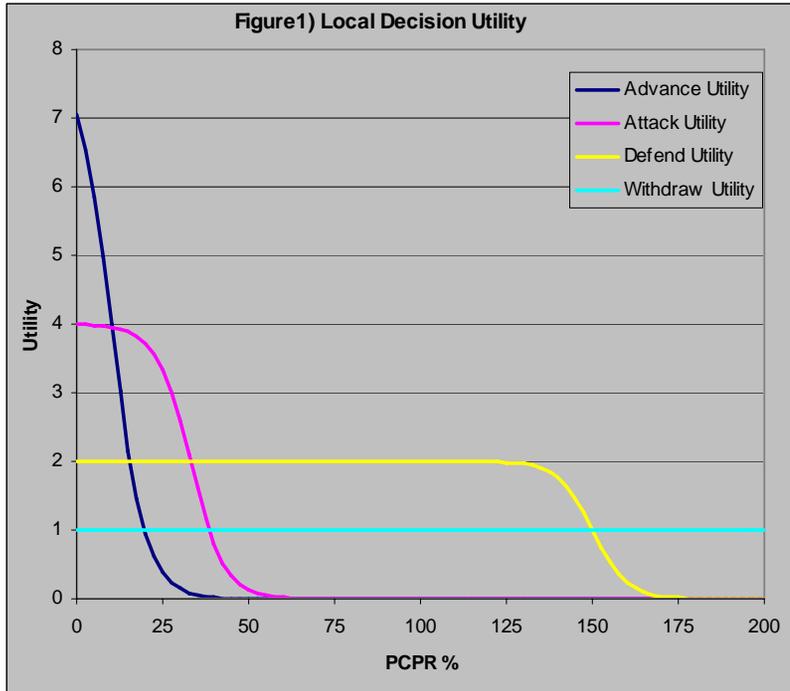
If $\text{Utility}(\text{local_decision}) - \text{Utility}(\text{global_decision}) > \text{Crit}$ then DO local otherwise DO global

α represents the decision autonomy of an individual commander.

V is a property of the command and control system and defines the degree of value flexibility in the C2 structure

- high V represents a very top down C2 structure
- low V implies a mission-command type of structure

Computing Utility for each decision



Assignment of Support Unit re-allocations

1: Top-down	No re-allocation possible – all fixed
2: Intermediate	Re-allocation of Long-range artillery
3: Edge	Re-allocation of Attack Helicopters, Long-range artillery & manoeuvre units

Terminology

- Force sizes
 - A, B, C and D
- Vignettes – 2 sided high intensity war fighting
 - DD_2_5 Meeting engagement
 - DD_0_5 Meeting engagement
 - DD_1_5 Meeting engagement
 - AB_2_5 Attack
- Runs
 - Sets of 50 runs
- C2 Configurations
 - 1,2 and 3

attacking versus defending force vignettes

2 sided - large attacker (blue) 2x size of defender (red)

	Operational Environment	Building Blocks	C2 Configurations
Configuration A1B2	Fixed and constant across the runs	Fixed and constant across the runs	Attacking force: Top down Defending force: Intermediate
Configuration A2B2	Fixed and constant across the runs	Fixed and constant across the runs	Attacking force: Intermediate Defending force: Intermediate
Configuration A3B2	Fixed and constant across the runs	Fixed and constant across the runs	Attacking force: Edge Defending force: Intermediate

Meeting engagement vignettes

2 equal sized forces (red and blue)

	Operational Environment	Building Blocks	C2 Configurations
D1 vs D1	3 variations	Fixed	Top-down vs Top-down
D1 vs D2	3 variations	Fixed	Top-down vs Intermediate
D1 vs D3	3 variations	Fixed	Top-down vs Edge
D2 vs D1	3 variations	Fixed	Intermediate vs Top-down
D2 vs D2	3 variations	Fixed	Intermediate vs Intermediate
D2 vs D3	3 variations	Fixed	Intermediate vs Edge
D3 vs D1	3 variations	Fixed	Edge vs Top-down
D3 vs D2	3 variations	Fixed	Edge vs Intermediate
D3 vs D3	3 variations	Fixed	Edge vs Edge

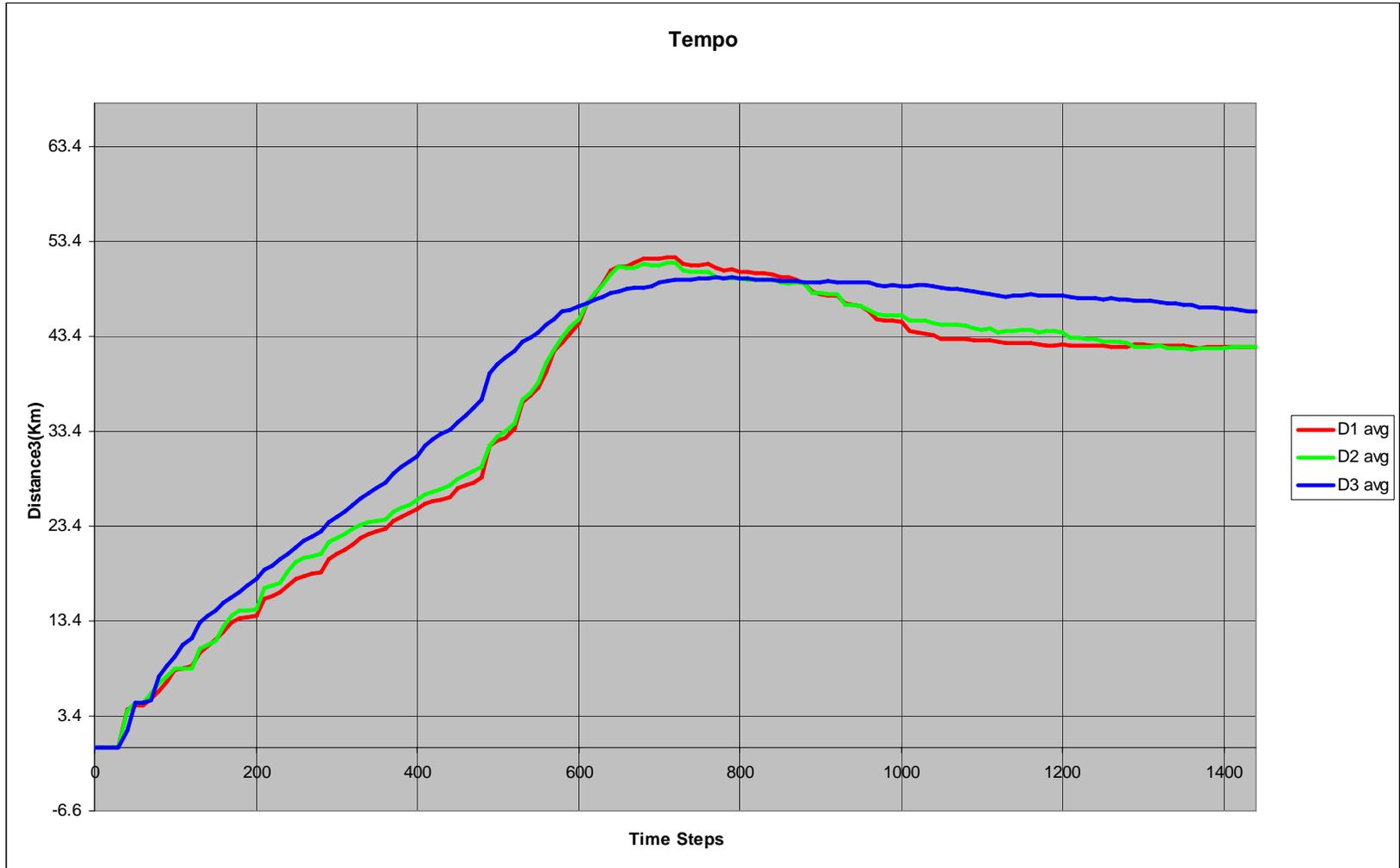
Experimental results

- C2 modelling and simulation for Edge Organisations
 - Casualties and Tempo metrics

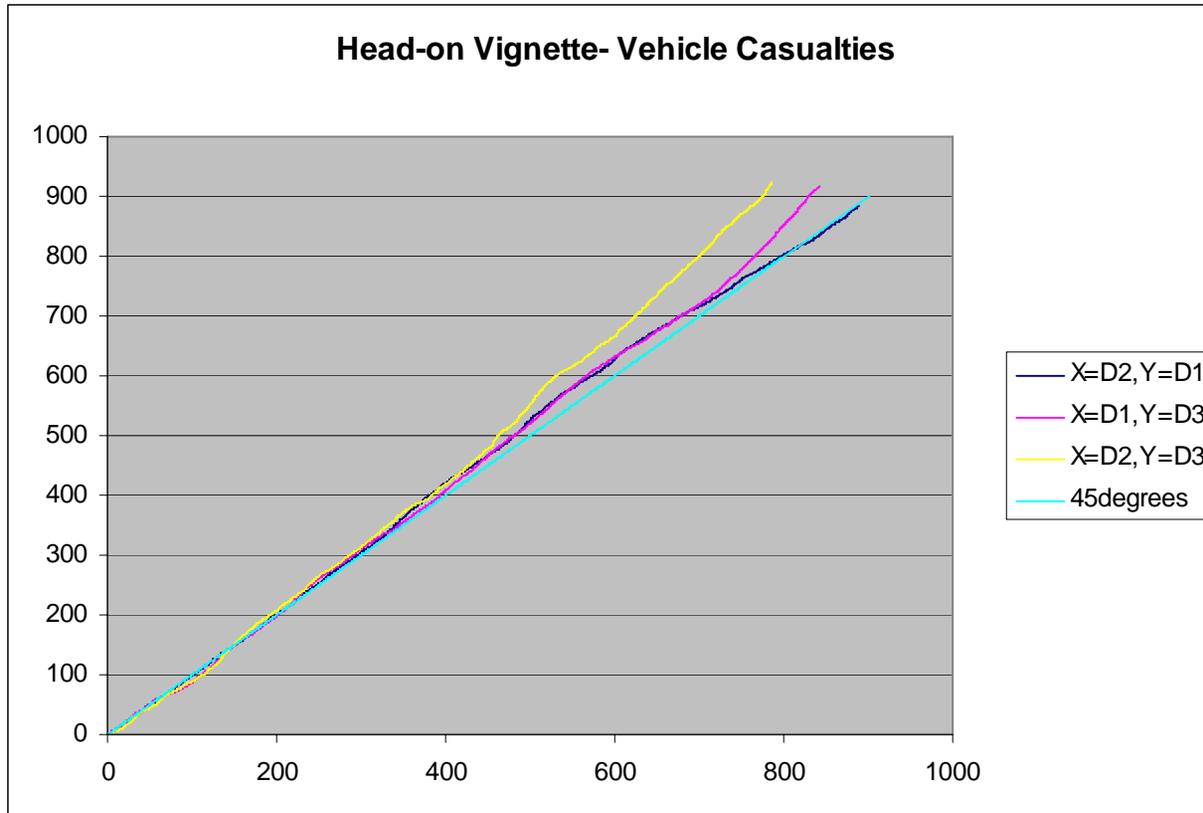
- C2 Performance Studies (NEC)
 - Casualties and Tempo metrics

- Logistics C2
 - Logistics performance metrics

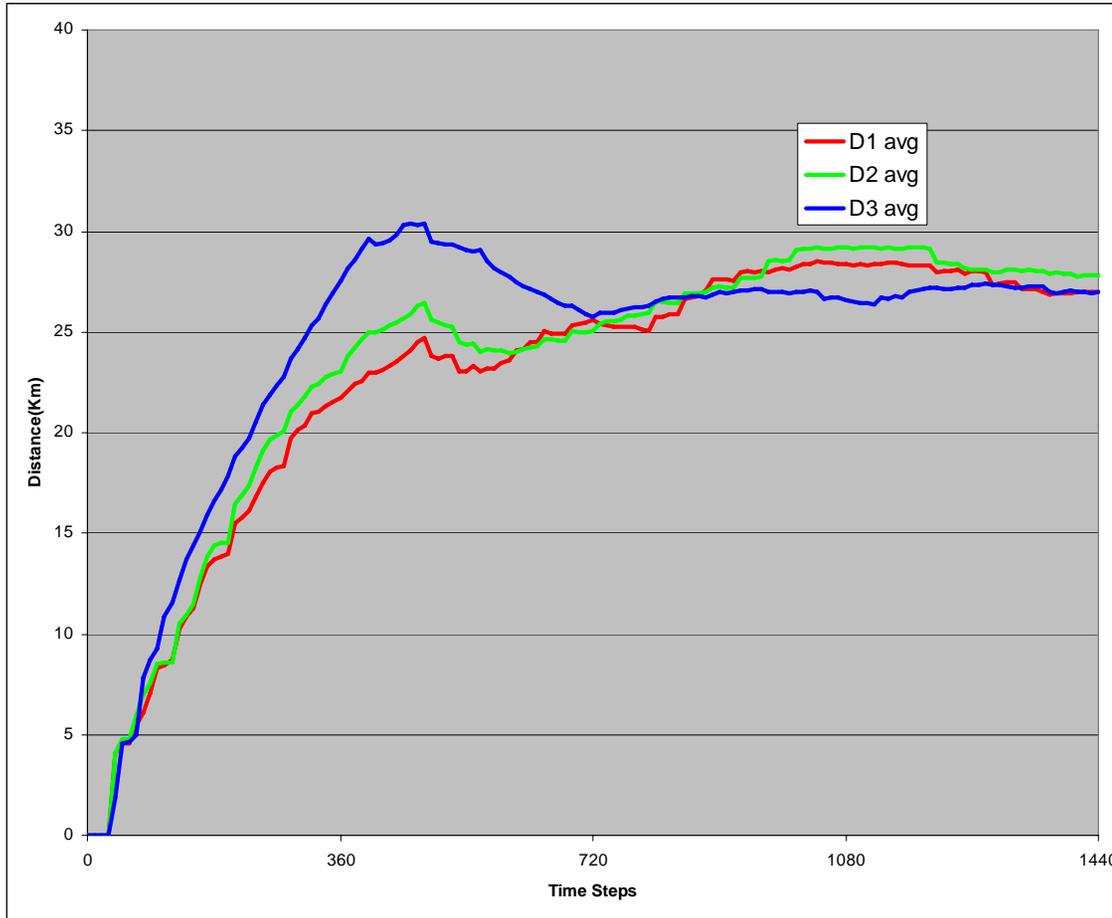
DD_2_5 – head-on meeting engagement



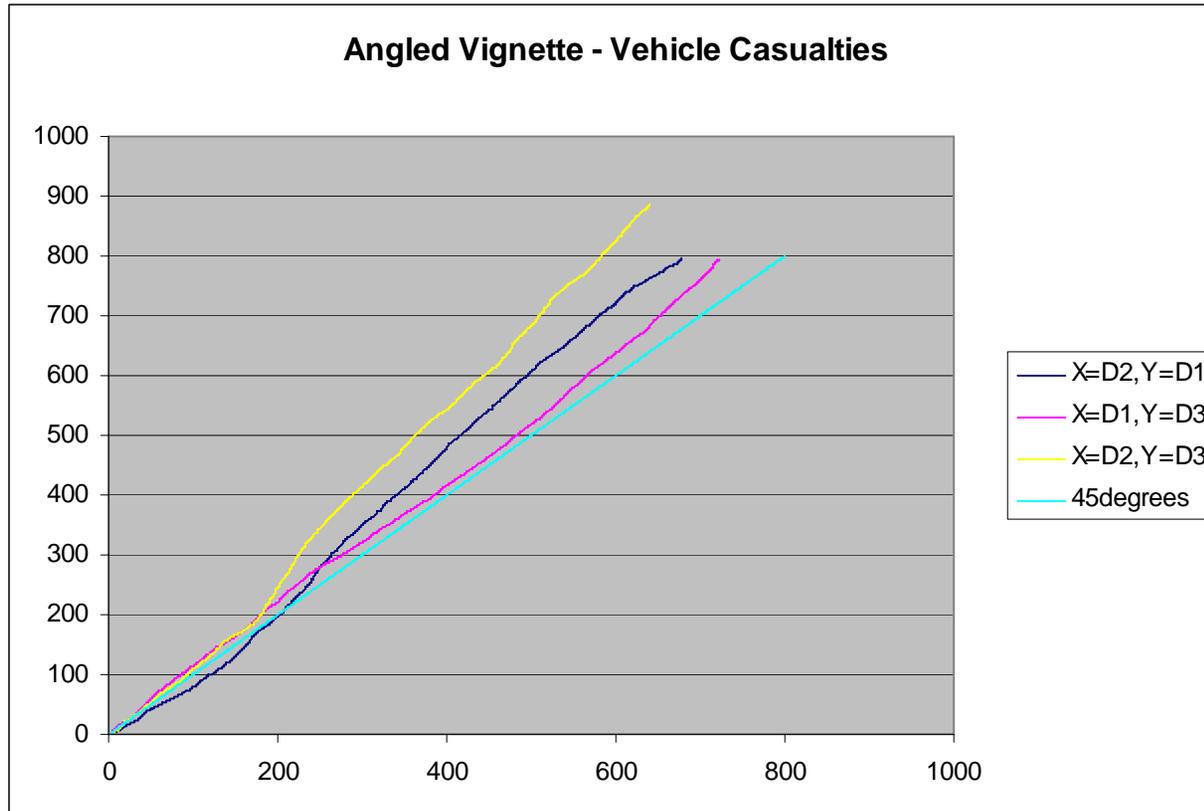
DD_2_5 Head-on Meeting Engagement Vignette



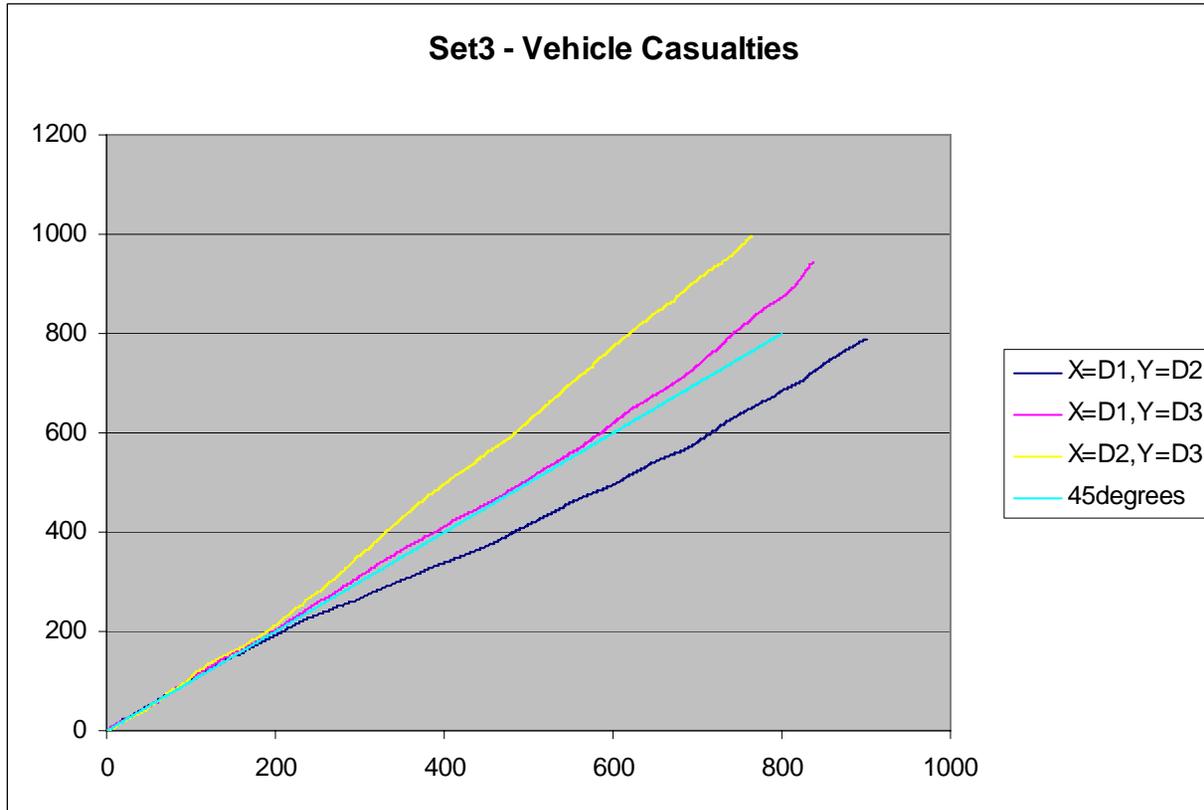
DD_0_5 Angled Meeting Engagement Vignette



DD_0_5 Angled Meeting Engagement Vignette



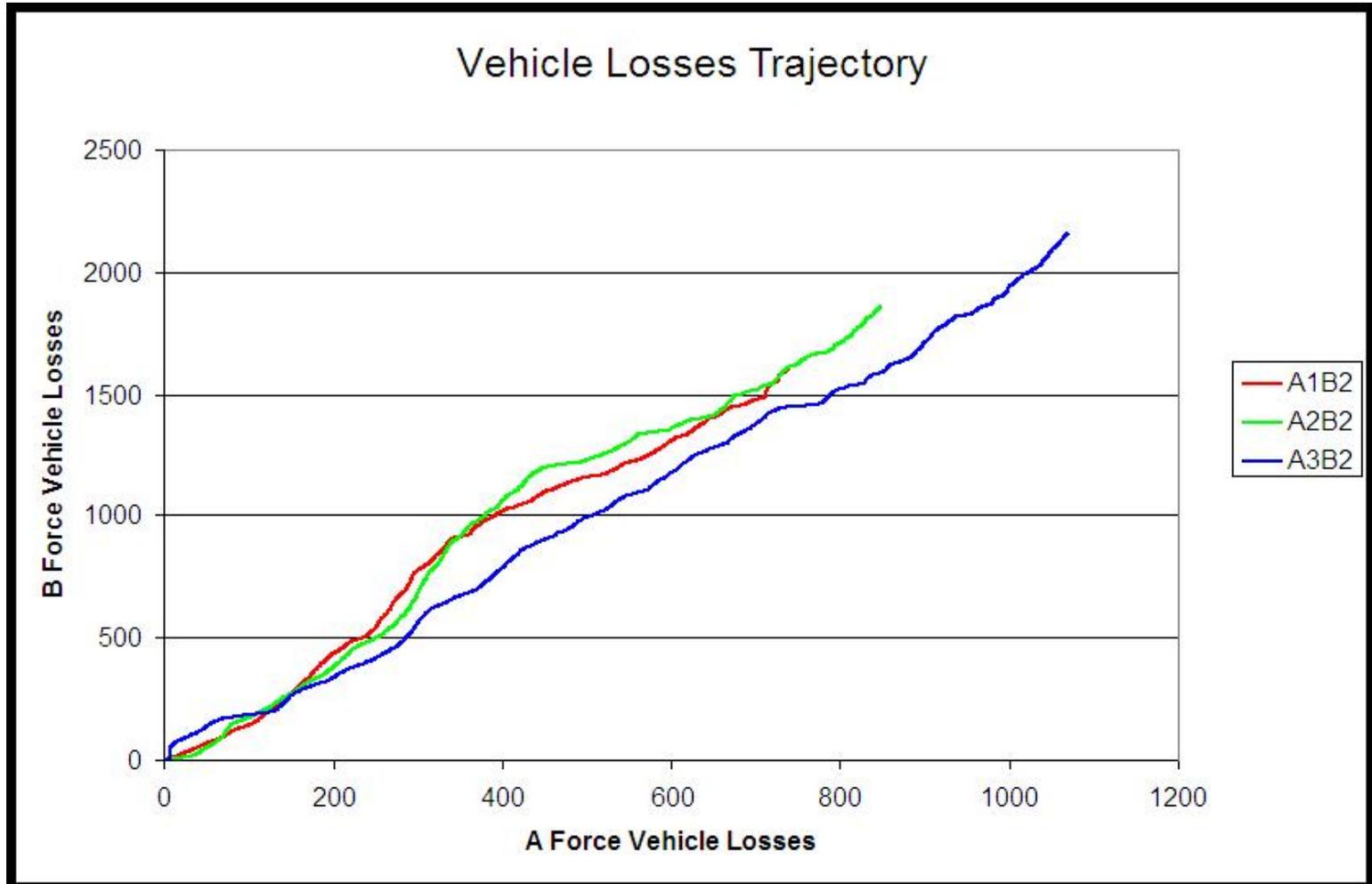
DD_1_5 Meeting Engagement Vignette



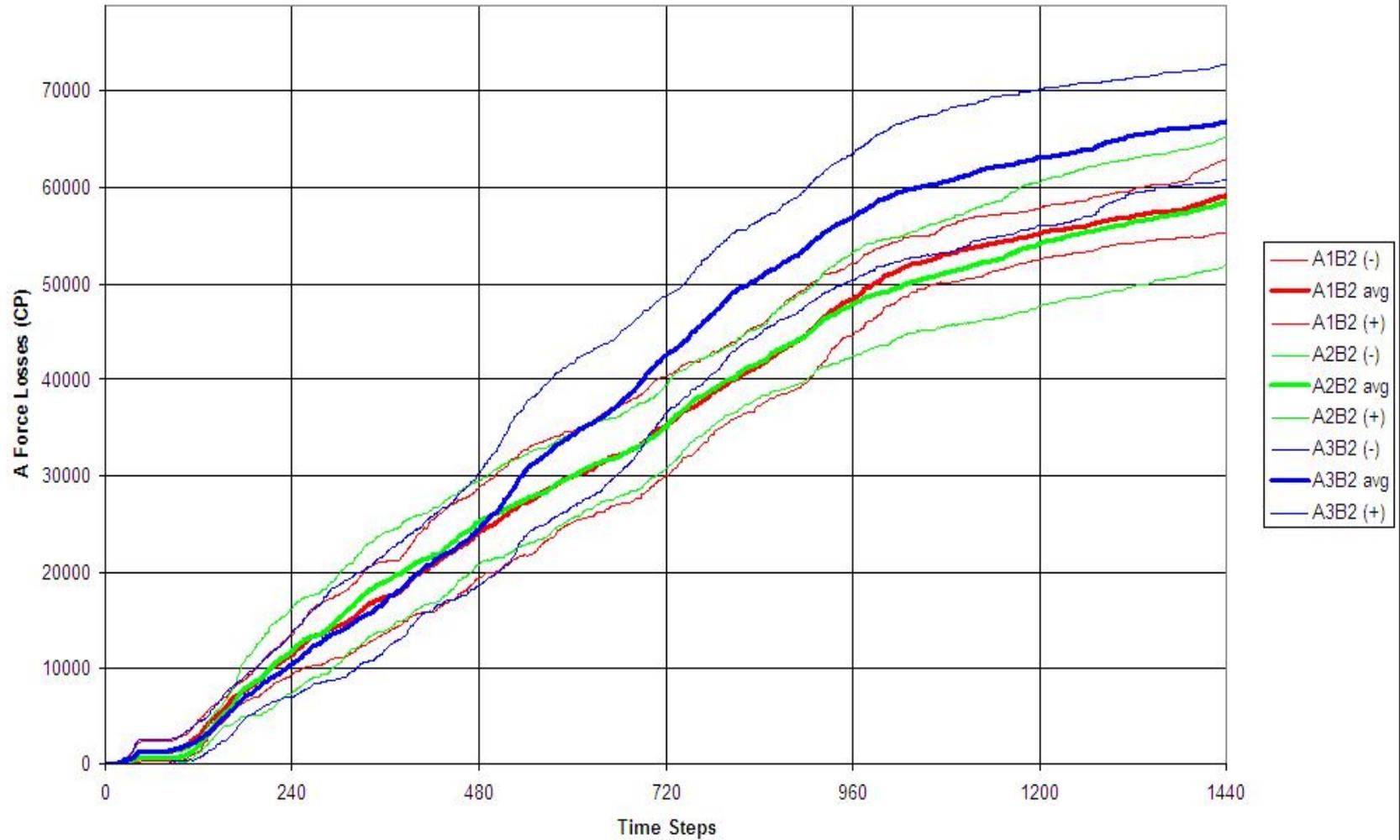
AB_2_5 : Attack Defence Vignette



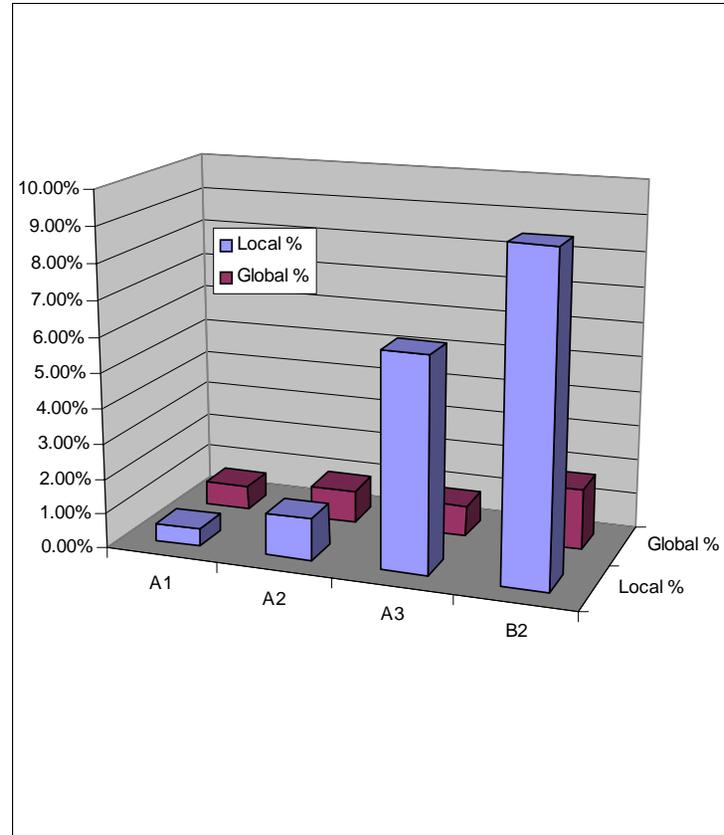
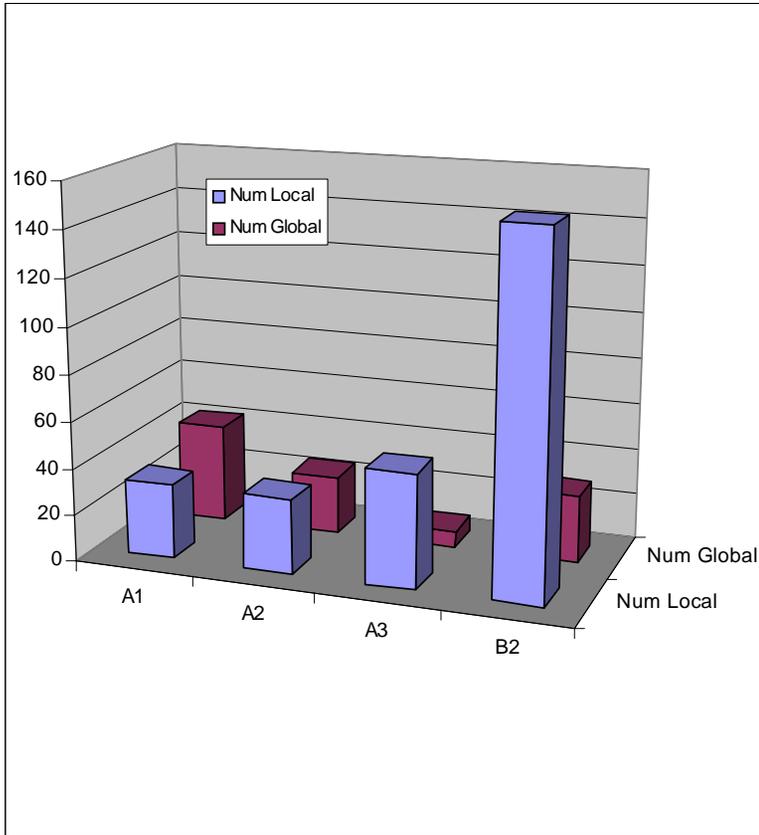
AB_2_5 : Attack Defence Vignette



Attacking Force Combat Power Losses over time

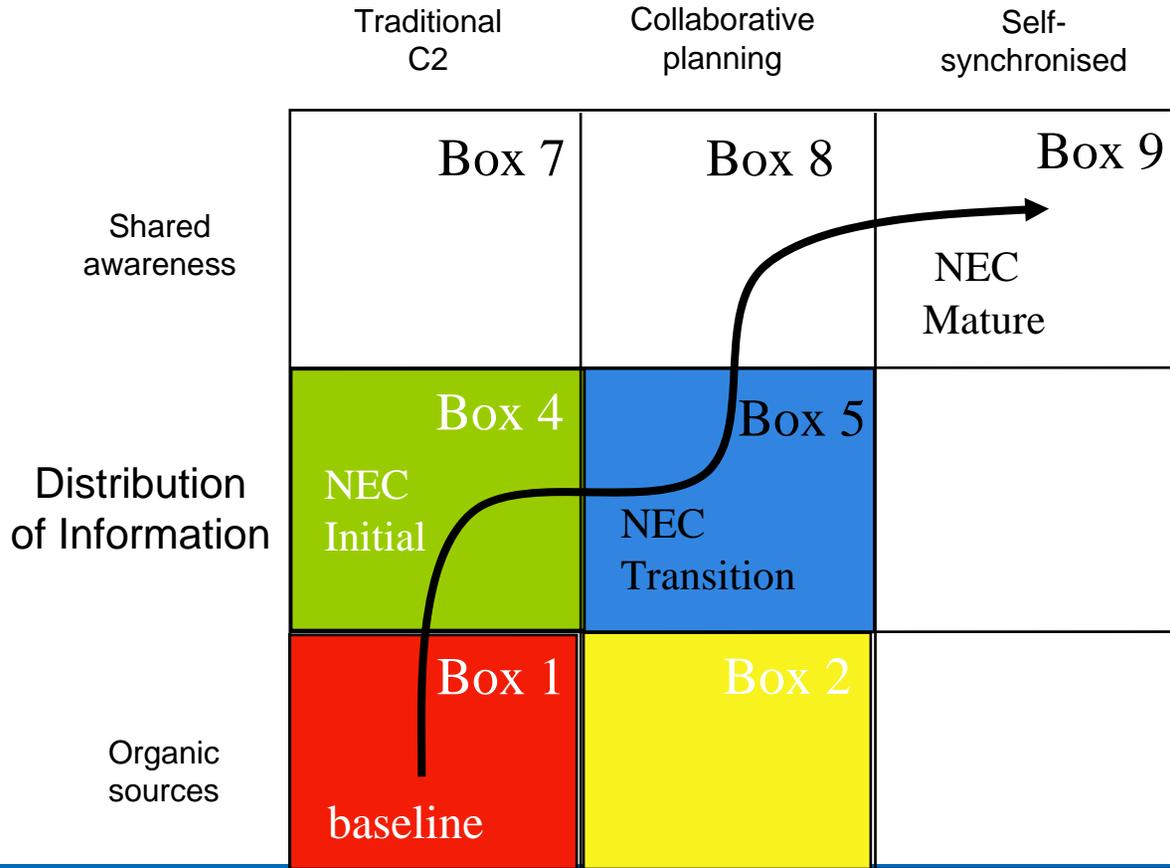


Comparison of number of local vs global decisions selected for each of the C2 configurations

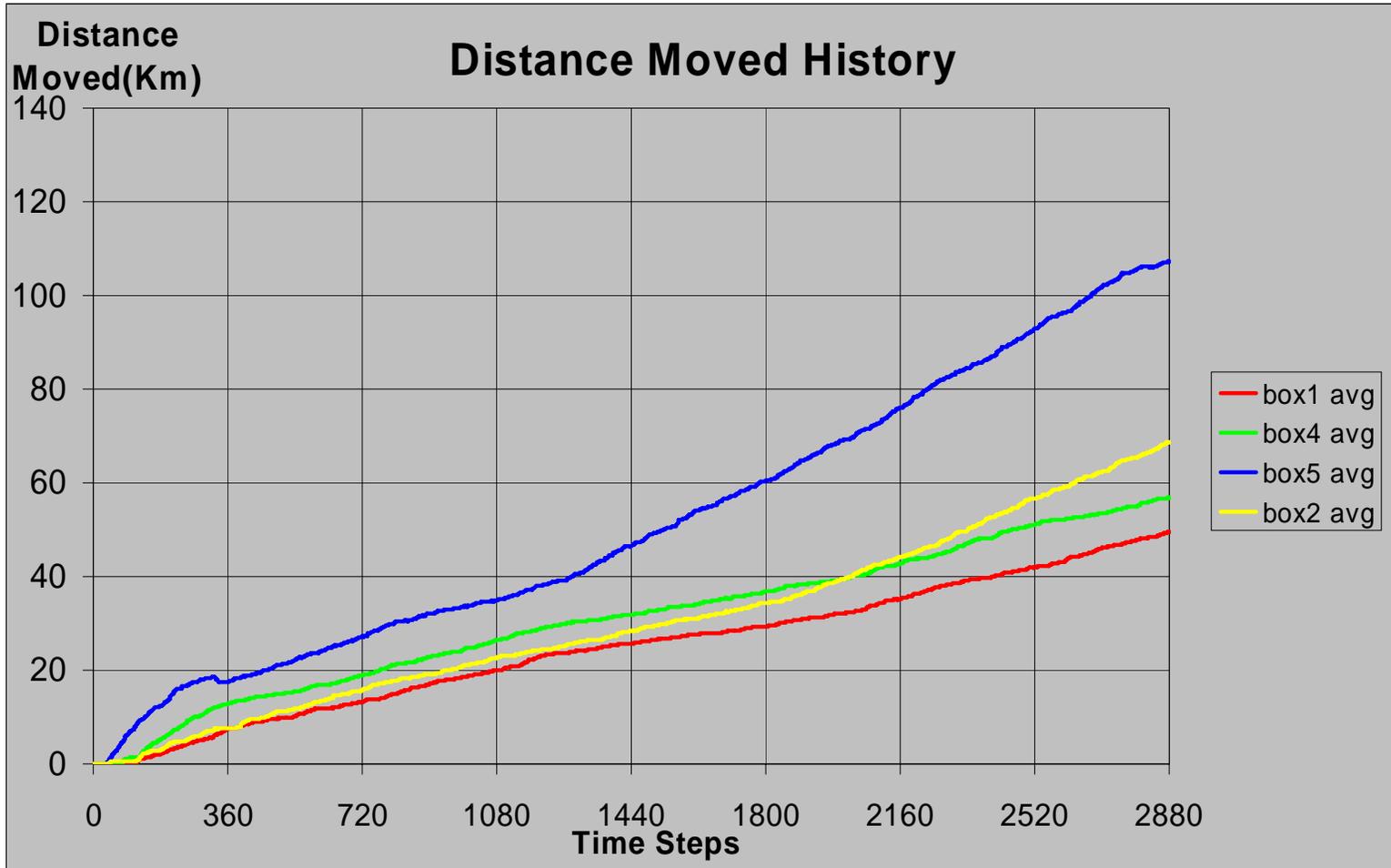


The NEC journey :- Investigations for the MoD FHQ programme

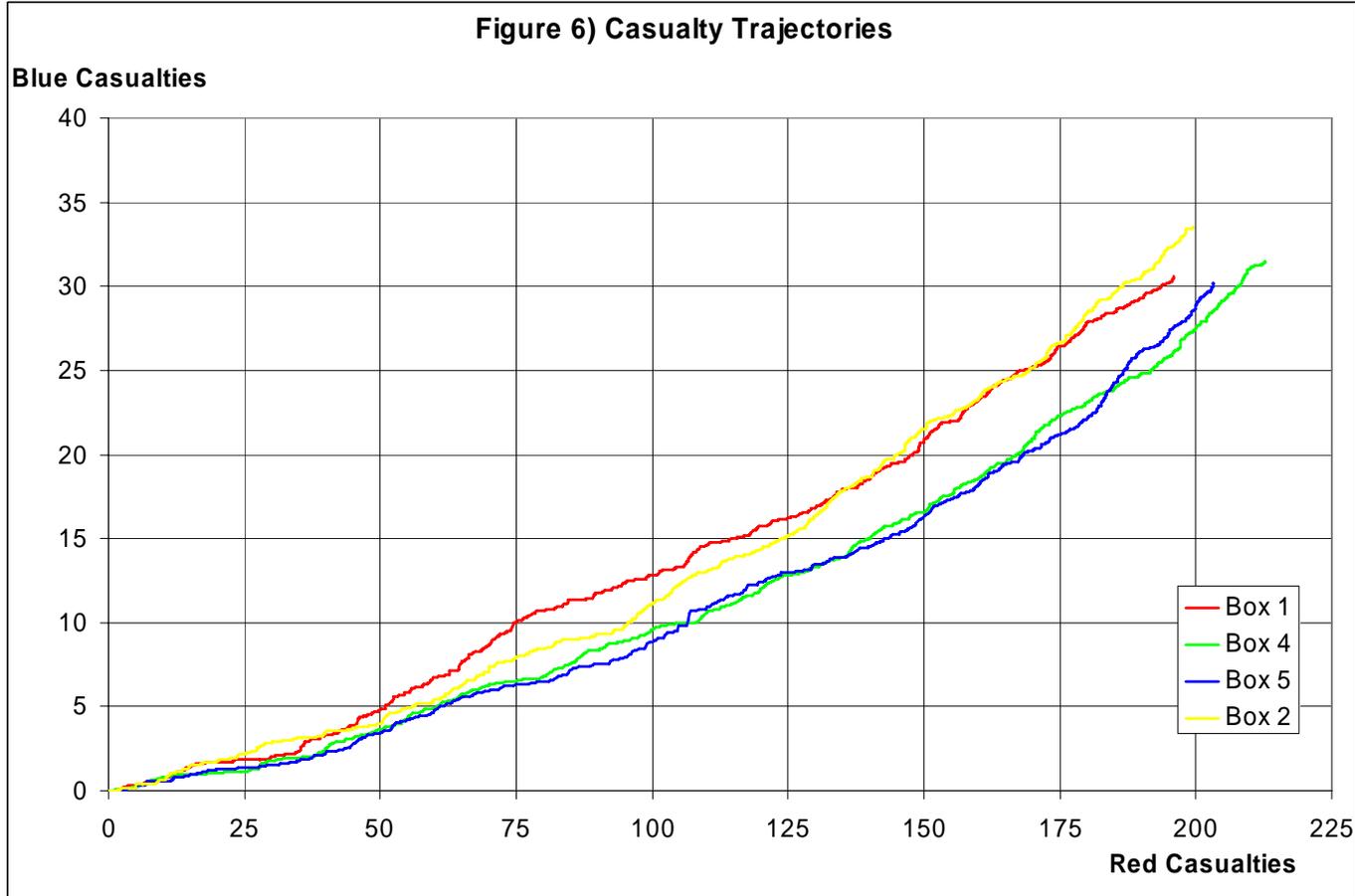
Patterns of Interaction



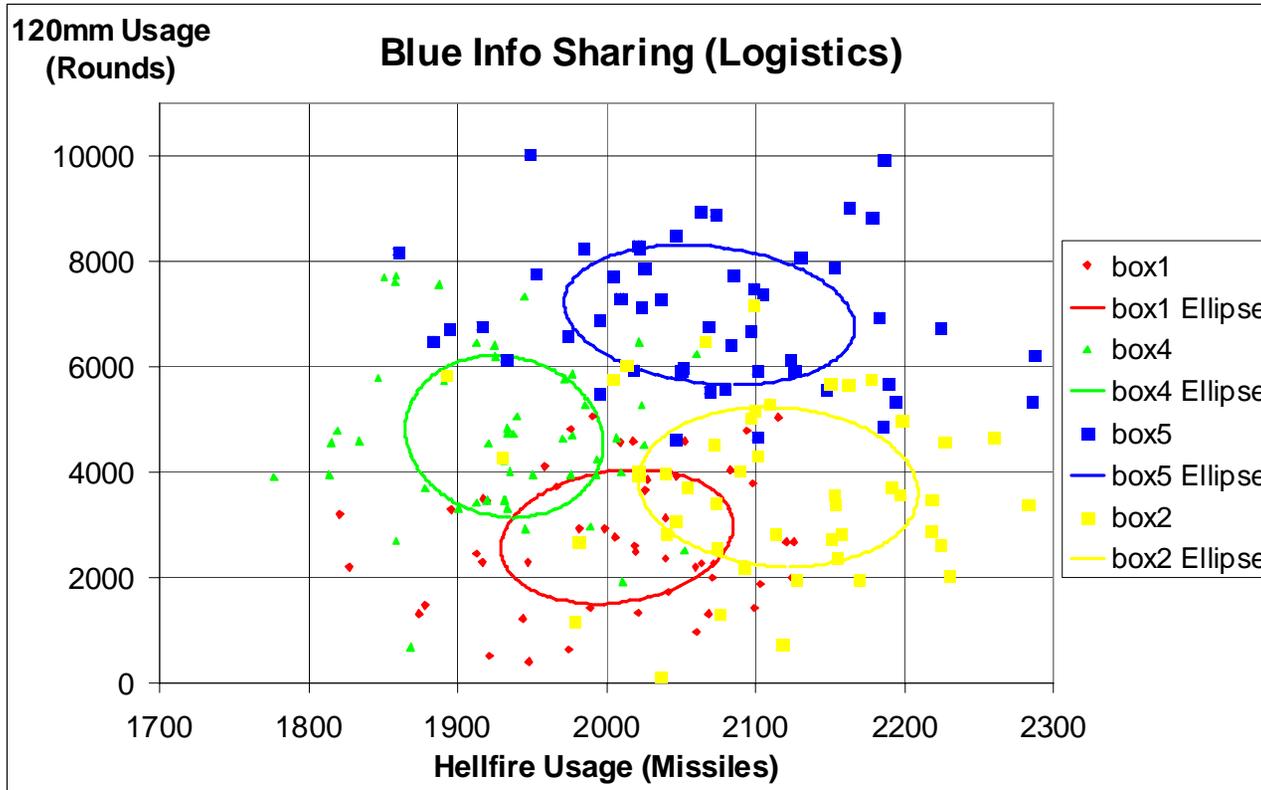
Non-Linear Improvements in Tempo moving from box 4 to 5



Impact of Info Sharing on Operational Effectiveness

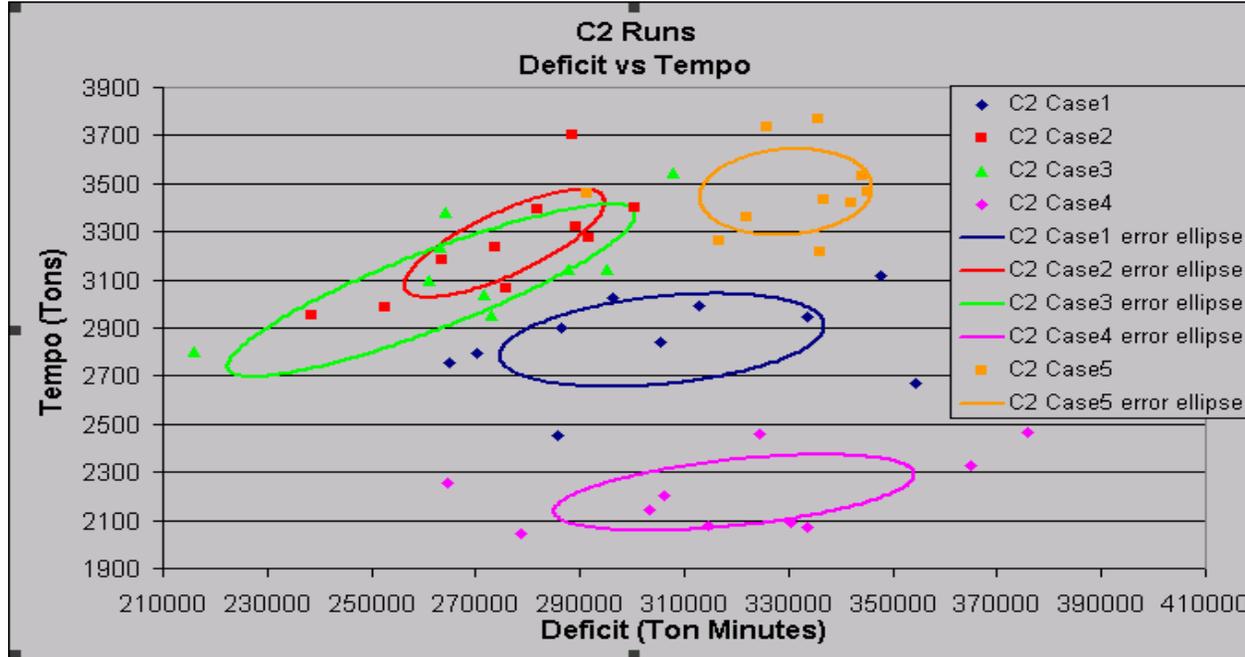


Varying Patterns of behaviour



Logistics C2:- Studies to Support HLDC IGBC

	Case1	Case2	Case3	Case4	Case5
Convoy behavior	Low SA No re-tasking	High SA (BFT) Limited Retasking	High SA (BFT) High Retasking	Low SA No re-tasking	High SA (BFT) Limited re-tasking
Convoy size	6	6	3	6	6
Node structure	Baseline	Baseline	Baseline	De-layered	Asset tracking



Summary

- We have presented:
 - An initial mapping across from the set of organisational attributes to the parameters in the HiLOCA combat simulation.
 - Comparisons of operational effectiveness of three different types of C2 configuration and also an investigation into outcomes in meeting engagement vignettes
- We have found that:
 - Edge configuration allows forces to achieve greater operational tempo than the top-down directed forces (including early initiative to strike with well-placed indirect fire assets).
 - Variability of outcomes is greater for Edge configuration than for Top-down
 - Intermediate configuration results in fewer losses (both personnel and vehicles) than the other two configurations when forces are in contact.
 - Number of local decisions (Edge behaviour) is greater for defensive force than attacking force while both are in Intermediate configuration.

Questions?

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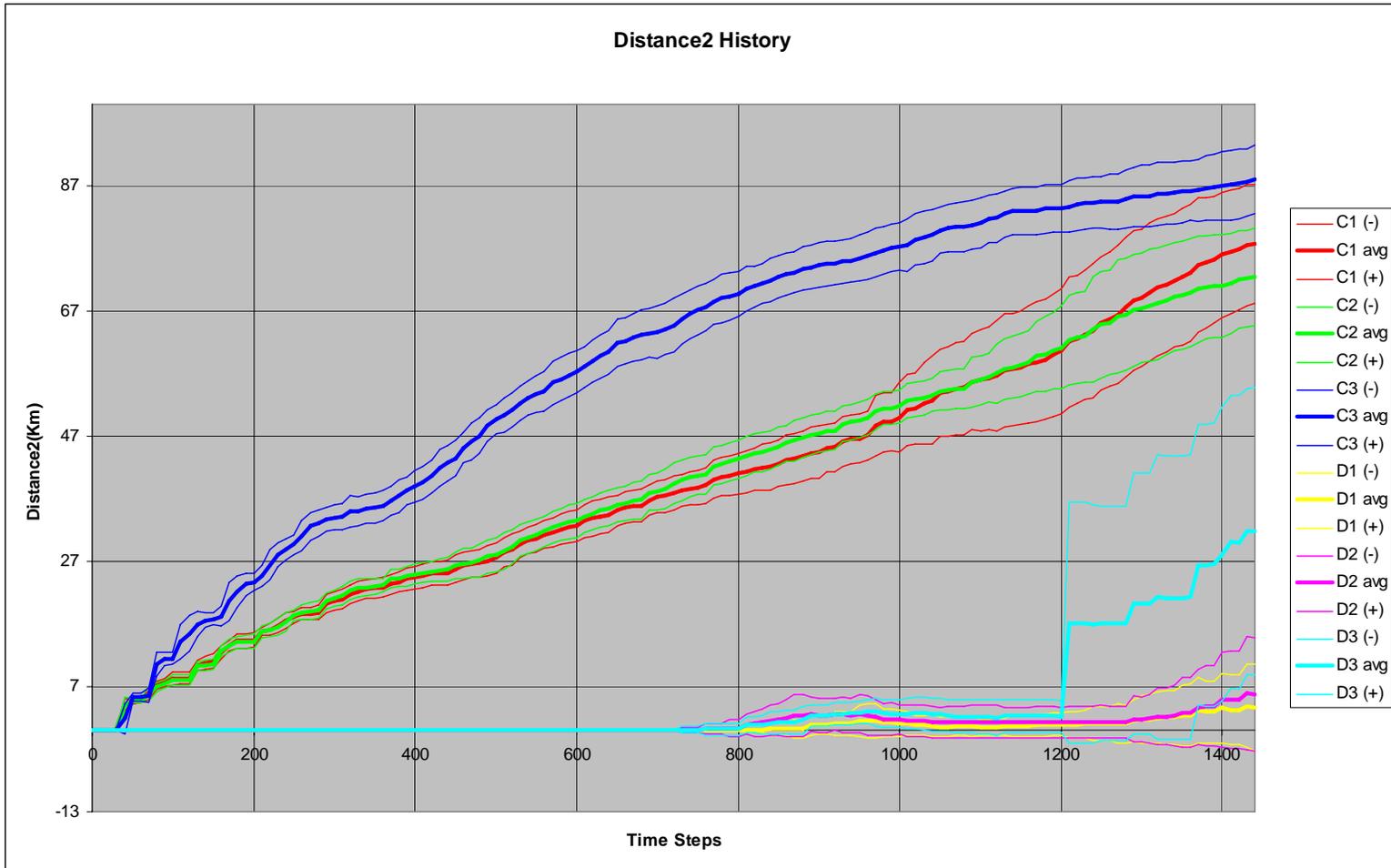


Figure 5) Red Casualty History

Red Casualties

