www.nsc.co.uk

August 19

IICM Human Terrain Modelling

David Robson

ISMOR 36

nsc

training • simulation • consultancy

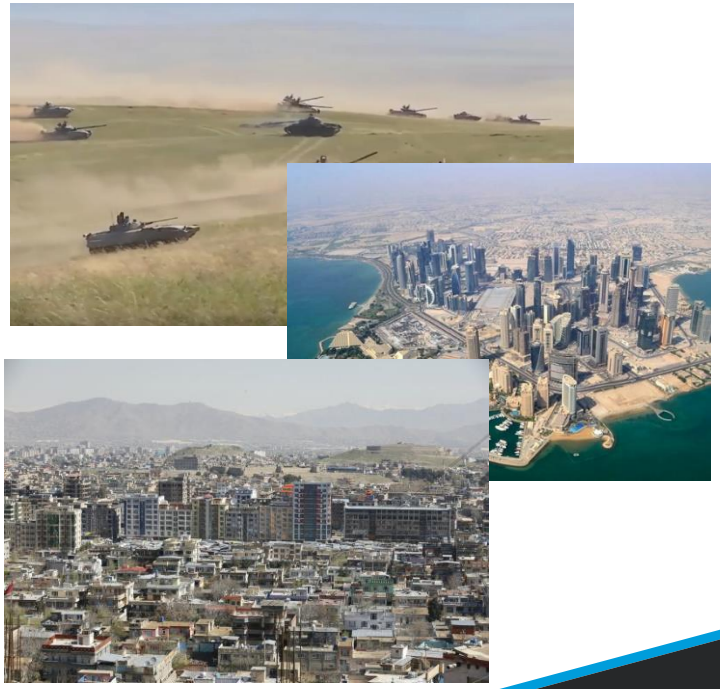
What are NSC doing…

Investigating methods of representing: -

- Non Linear Battlespace.
- Complex Urban Environments.
- Cyber and CEMA effects.
- Impact of the ‘Human Terrain’ on military operations.

Applied to: -

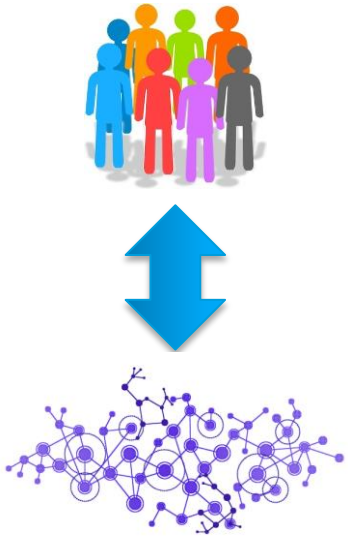
- Command and Control Exercises.
- Operational Analysis.
- Data visualisation.



nsc
training • simulation • consultancy

Influence and Infrastructure Combat Model (IICM)

A Hybrid Warfare model that links infrastructure networks and the behaviour of dependent human populations.



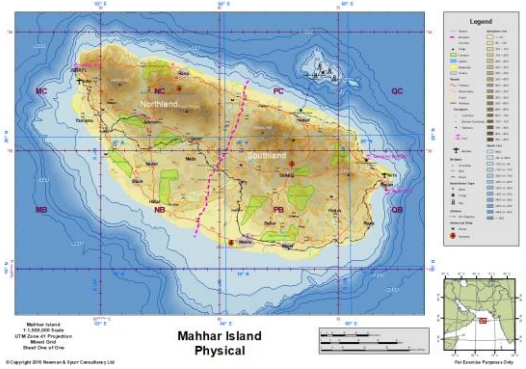
- Enables identification and analysis of 1st , 2nd and 3rd order impacts of attacks and disruption across a human terrain.
- Link to cyclical (time dependent) models.
- Explore the impact of Influence Operations and Cyber.
- Indicative, not Predictive.
- Completed 1 of 3 expected project phases.

“To explore the effects of cyber and other hybrid operations on a civil population”

Key Requirements

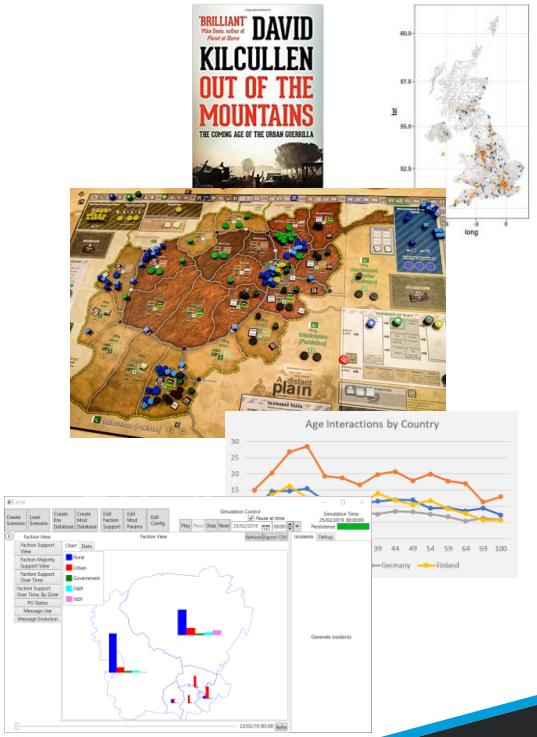
A Wargame model for Training and Analysis

- Work with real world and fictional settings and scenarios.
- Comprehensible output for both Analyst and Training Audience.
- Limited feedback loops.
- Link to other models (Kinetic, Cyber, Economic).
- Reacts to: -
  - Information Operations
  - Kinetic Events
  - Cyber Effects
  - Environment (CNI) Disruption
- Low cost of tools and supporting data.



Project Methodology

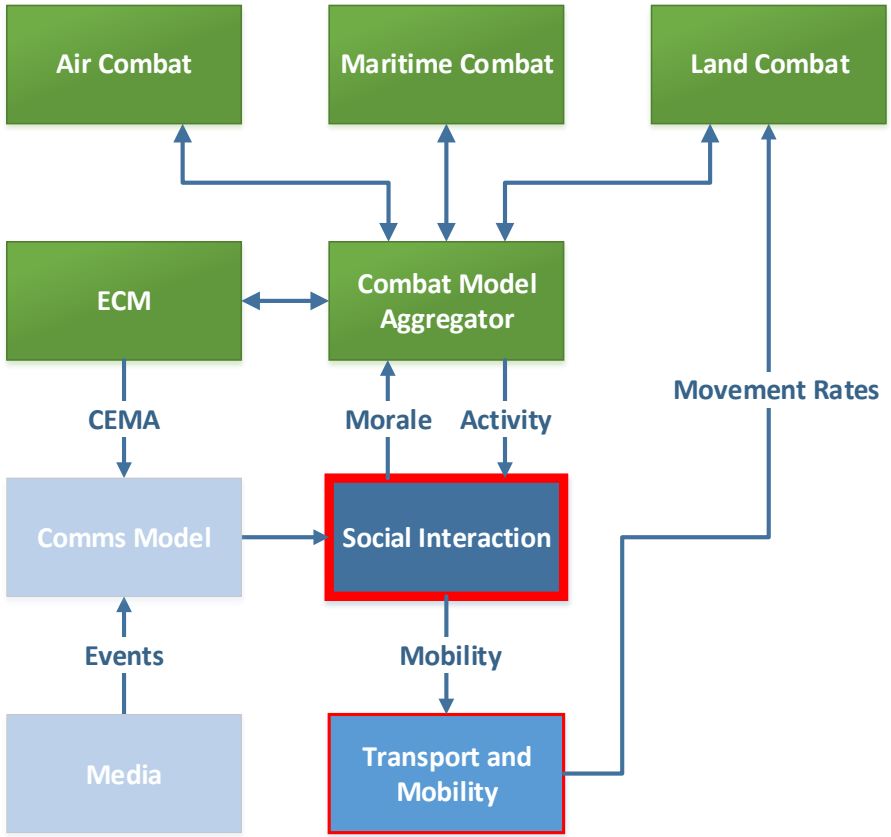
- Investigate COTS gaming solutions.
- Review academic studies: -
  - Social Interaction models
  - Counter-Insurgency and Influence operations
  - Urban Modelling
  - Infectious Disease models
- Identify open source datasets.
- Design a notional model.
- Construct software application to demonstrate technical viability.
- Test model on a UK teaching exercise to evaluate output.



nsc
training • simulation • consultancy

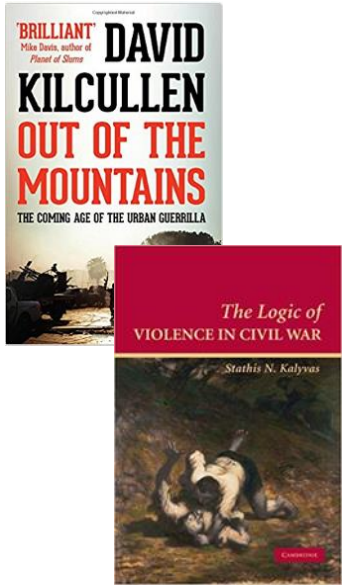
Key Model Components

- Military activity affects the population. *"Combat Model Aggregator".*
- Cyber and CNI disruption change electronic communications. *"Capacity based Comms model"*.
- People move over a daily cycle between different geographic areas. *"Arc-Node based Transport and Mobility model".*
- Messages most effective when passed face-to-face. *"Agent based Social Interaction model".*



Urban Areas and Cities

- Conflict takes place where the people are.
- Cities are: -
  - Densely populated
  - Rapidly evolving
  - Highly networked
- Cities **influence** surrounding areas. Destination for transport systems and trade.
- Cities contain **transient** populations with strong social connections back to their former communities.
- Cities are **contested** areas with competition between different communities and groups.



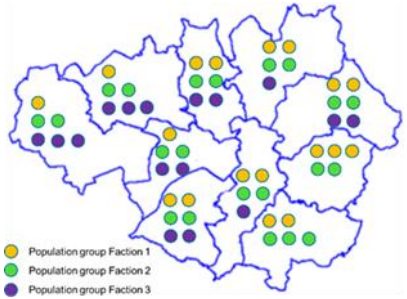
Ref : David Kilcullen "Out of the Mountains" 2015
S. N. Kalyvas "Logic of Violence" 2006

nsc
training • simulation • consultancy

Social Interaction Model

Agent based model

- Map split into geographical districts based on census data regions and Urban Terrain Zone classifications (UTZ).
- Population modelled as groups of people with shared beliefs and mobility who move between zones. 50-250 people per group.
- Sentiment modelled as memetic ‘packets of influence’ that are passed between population groups.
- Model calculates support for a faction at a given time.



Group Dynamics

People belong to multiple groups: -

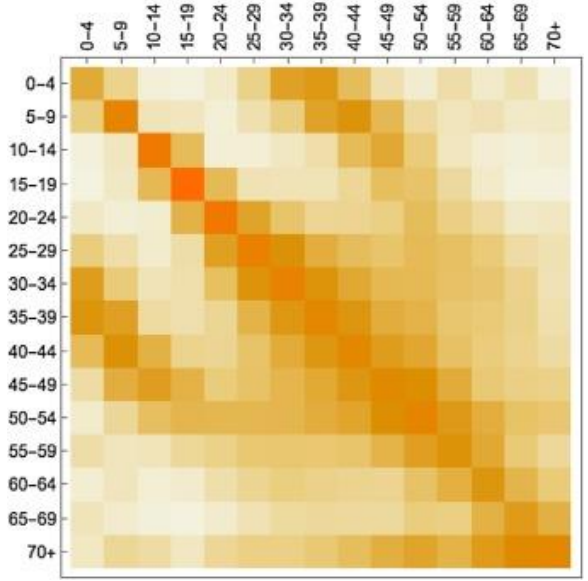
Group	Examples	Duration	Orientation	Model
Primary	Family, Close Friends, Gangs	Long	Relationship	**Home Zone**
Social	Co-Workers, Sports Teams	Medium	Task	**Work Zone**
Categories	Political, Religion	Medium	Self Identified	**Faction**
Collective	Flash Crowd, Audience	Short	Spontaneous	**Emergent**

Key to modelling *'Influence Operations'*

Population Age Communication Factors

Age of an individual affects the chance of social interaction.

- Defined a Population Group by: -
  - Home Location (Primary Group)
  - Work Location (Social Group)
  - Faction (Categories Group)
  - Age Band
- Constructed a related 24 hour activity cycle per age band



Adding Age factor results in more PG entities and more complex data setup but much better information flow.

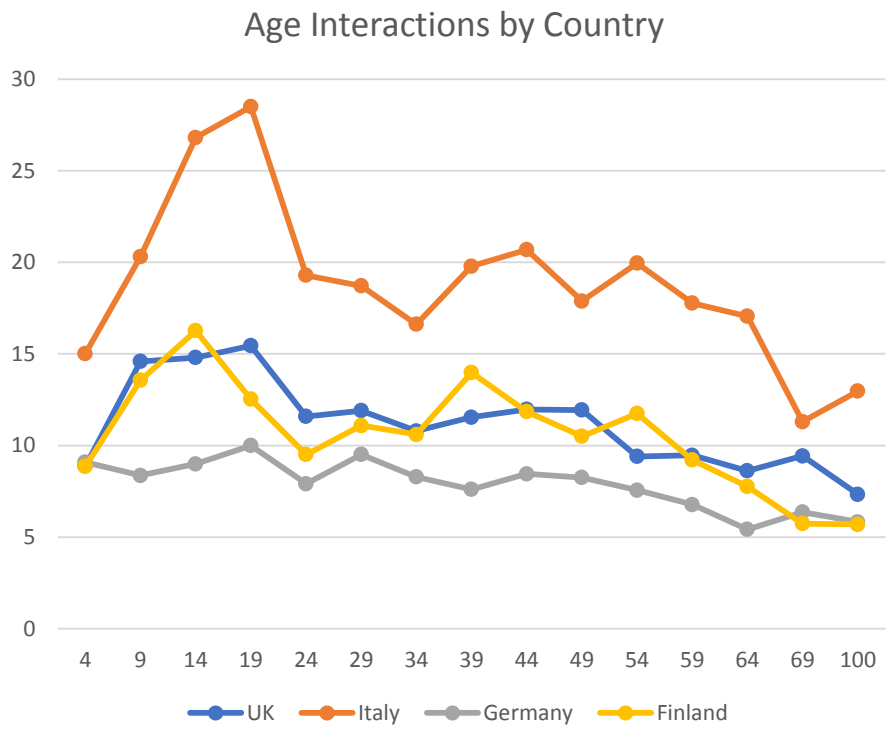
Social Contacts and Mixing Patterns Relevant to the Spread of Infectious Diseases : Mossong et al. 2008

Population Cultural Factors

Germany							
Age	00-09	10-19	20-29	30-49	50-64	65+	SUM
00-09	2.66	0.33	0.28	1.01	0.41	0.24	**4.92**
10-19	0.90	4.70	0.73	2.38	0.47	0.58	**9.75**
20-29	0.93	1.08	3.48	1.96	1.18	0.44	**9.05**
30-45	1.57	1.16	1.28	3.98	1.59	0.93	**10.50**
45-64	0.60	0.65	0.96	2.01	2.22	0.87	**7.31**
65+	0.69	0.36	0.39	0.97	1.00	1.71	**5.11**
SUM	**7.34**	**8.27**	**7.11**	**12.29**	**6.86**	**4.76**	**46.63**

UK							
Age	00-09	10-19	20-29	30-49	50-64	65+	SUM
00-09	5.08	1.24	1.28	2.68	0.89	0.54	**11.70**
10-19	1.23	8.06	1.45	2.96	1.12	0.93	**15.73**
20-29	1.10	1.17	3.60	3.15	2.22	0.89	**12.12**
30-45	1.86	1.85	1.80	4.87	2.44	1.22	**14.04**
45-64	0.64	0.79	1.16	2.88	2.27	1.22	**8.97**
65+	0.25	0.32	0.41	1.28	1.31	1.76	**5.31**
SUM	**10.16**	**13.41**	**9.69**	**17.81**	**10.25**	**6.55**	**67.86**

Italy							
Age	00-09	10-19	20-29	30-49	50-64	65+	SUM
00-09	8.30	0.90	0.56	3.66	1.75	0.57	**15.73**
10-19	1.33	17.97	1.34	3.57	4.79	1.36	**30.36**
20-29	0.88	1.79	7.44	4.41	2.88	1.15	**18.53**
30-45	2.43	1.88	3.15	9.20	4.21	1.89	**22.75**
45-64	1.10	1.72	2.01	4.67	4.23	1.83	**15.55**
65+	1.32	0.76	0.93	2.73	3.22	2.57	**11.52**
SUM	**15.35**	**25.01**	**15.42**	**28.23**	**21.07**	**9.36**	**114.43**

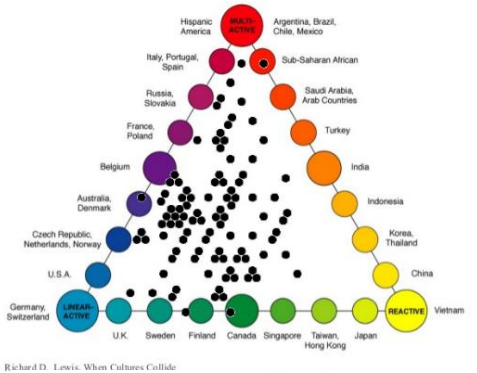


Cultural Distance

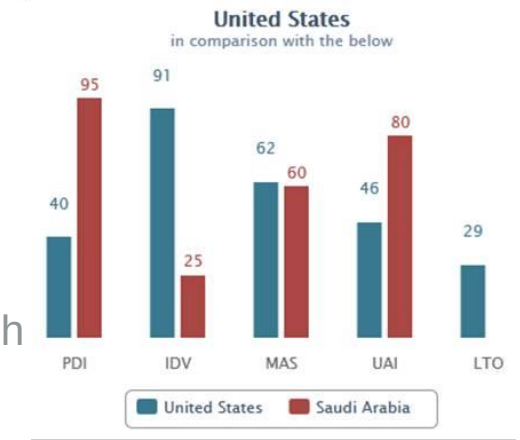
Evaluated multiple Cultural Distance (CD) models

- Lewis 3 way model used for Phase 1.
  - Simple data setup.
  - Easy to explain to training audience.
  - Pre-generated into a single ‘chance of successful communication’ factor between each Faction pair.

- Hofstede Cultural Dimensions model (6 way) proposed for Phase 2
  - Higher fidelity.
  - Allows each message to include cultural targeting factors
  - Avoids requirement for multiple messages to describe each event.



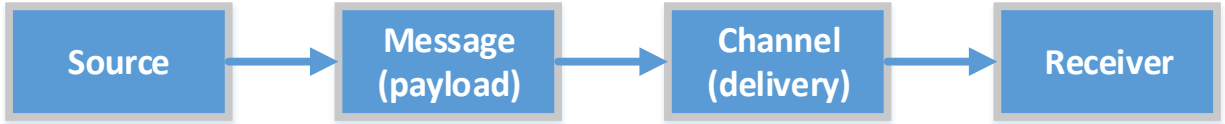
Richard D. Lewis, When Cultures Collide



Message Model - 1

IICM models the effects of discrete messages on population groups as changes in support for factions.

- Implements a modified Sender-Message-Channel-Receiver (SMCR) communication model.

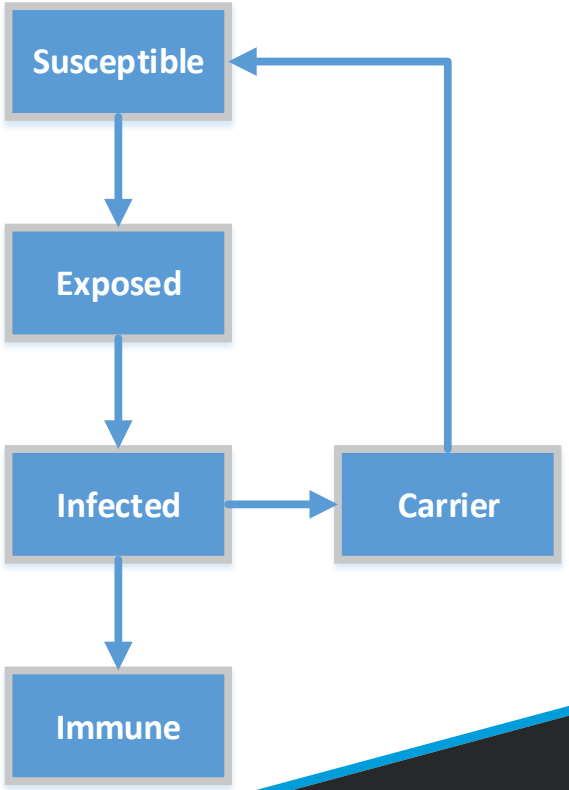


- Splits a message into a delivery mechanism and payload.
- Payload is a ‘Meme’ which conveys influence.
- Core model uses Hour long activity ticks.
- ‘Smoothing Model’ for social media effects.

Message Model - 2

Messages transmitted between co-located population groups using an infection-like (SEIR) modelling algorithm.

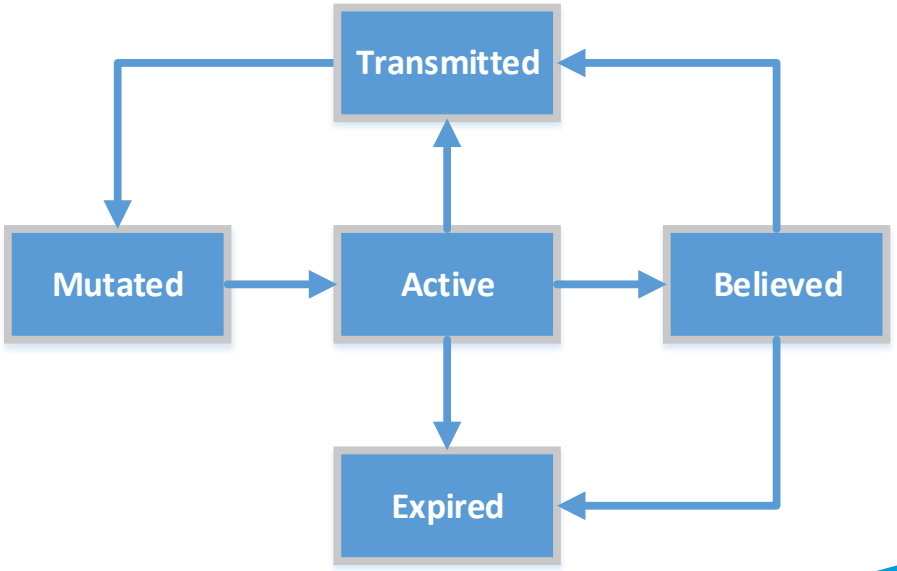
- Chance of interaction is population age dependent.
- ‘CD’ between source and potential host used to test for chance of infection (Successful communication).
- Intense messages are more virulent.
- A message can be passed on even if the host does not ‘believe’ it.



Message Model - 3

Messages have a life cycle in the host:

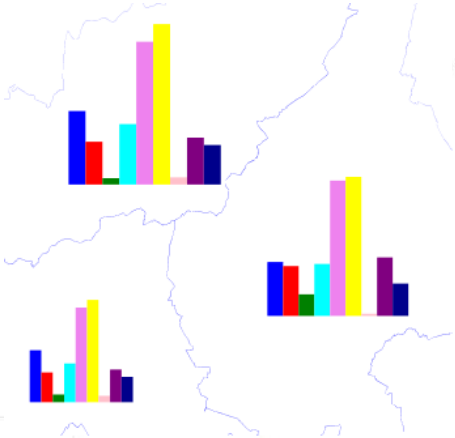
- Messages have an originator faction.
- Messages age and ‘Expire’.
- Expired messages are no longer infectious and give immunity.
- Active messages may be ‘Believed’ to deliver an influence change.
- Low CD value between originator and host = greater chance of belief.
- Messages may ‘mutate’ form as they are transmitted. High CD = greater chance of mutation.

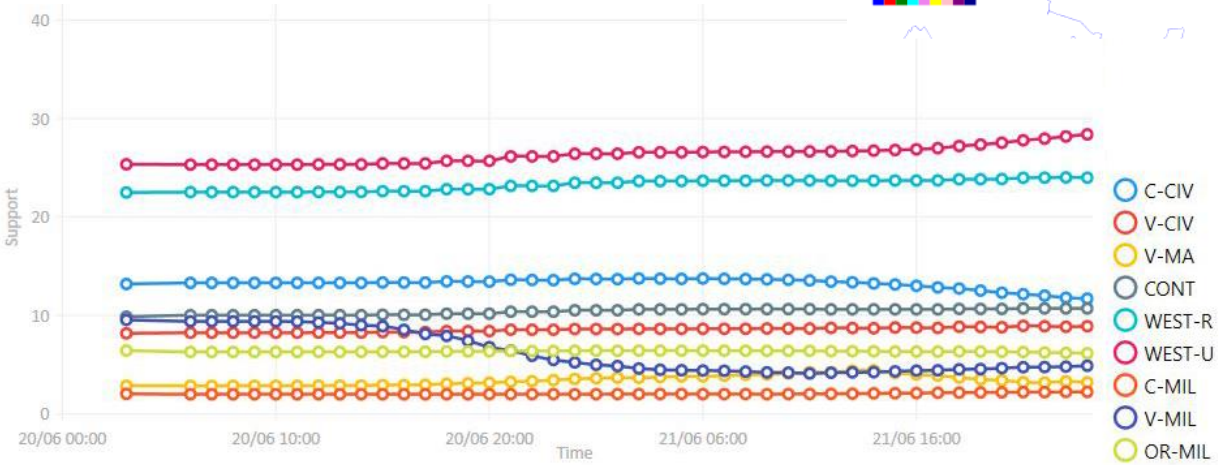


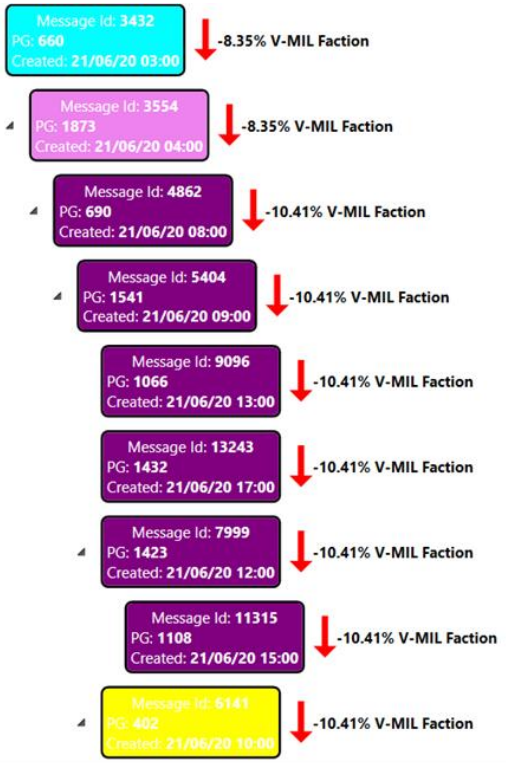
Sample Model Outputs

SQL Database including: -

- Faction Support over time
  - Whole scenario
  - By geographical region
- Message infection rates over time
- Message evolution over time







Phase 1 Conclusions

- An IICM type Human Terrain model shows promise for future wargames.
- Infection models provide a useful model of information flow in a population. Best suited for problems with
  - Regional focus (1000's to 1 million population), Town to UK County sized regions.
  - Interaction with external Geocentric models
  - Education and Training
- Census and infection modelling data provides a useful base dataset that does not require Social Media derived databases.
- Current model requires refinement to the Social Distance model to allow for wider cultural diversity.

QUESTIONS?

SPARE SLIDES

Manual COIN Wargames

COIN Series of Wargames published by GMT. Focused on Counter Insurgency Operations throughout history.

Key Design elements

- Terrain is split into provinces or political blocks, not hexes or other regular shapes.
- Forces are always visible, but they can only be attacked once they are located.
- Conflict is resource, not firepower, limited, so sustainability is a significant factor.
- More than two protagonists drives complex narratives.

Andean Abyss (2012) - Columbia 1990's
A Distant Plain (2013) – Afghanistan 2003-2013
Fire In the Lake (2014) - Vietnam 1964-1975
Falling Sky (2016) – Gaul 54BC
Colonial Twilight (2017) - Algeria 1954-1962
Pendragon (2017) - Britain 400-500 AD

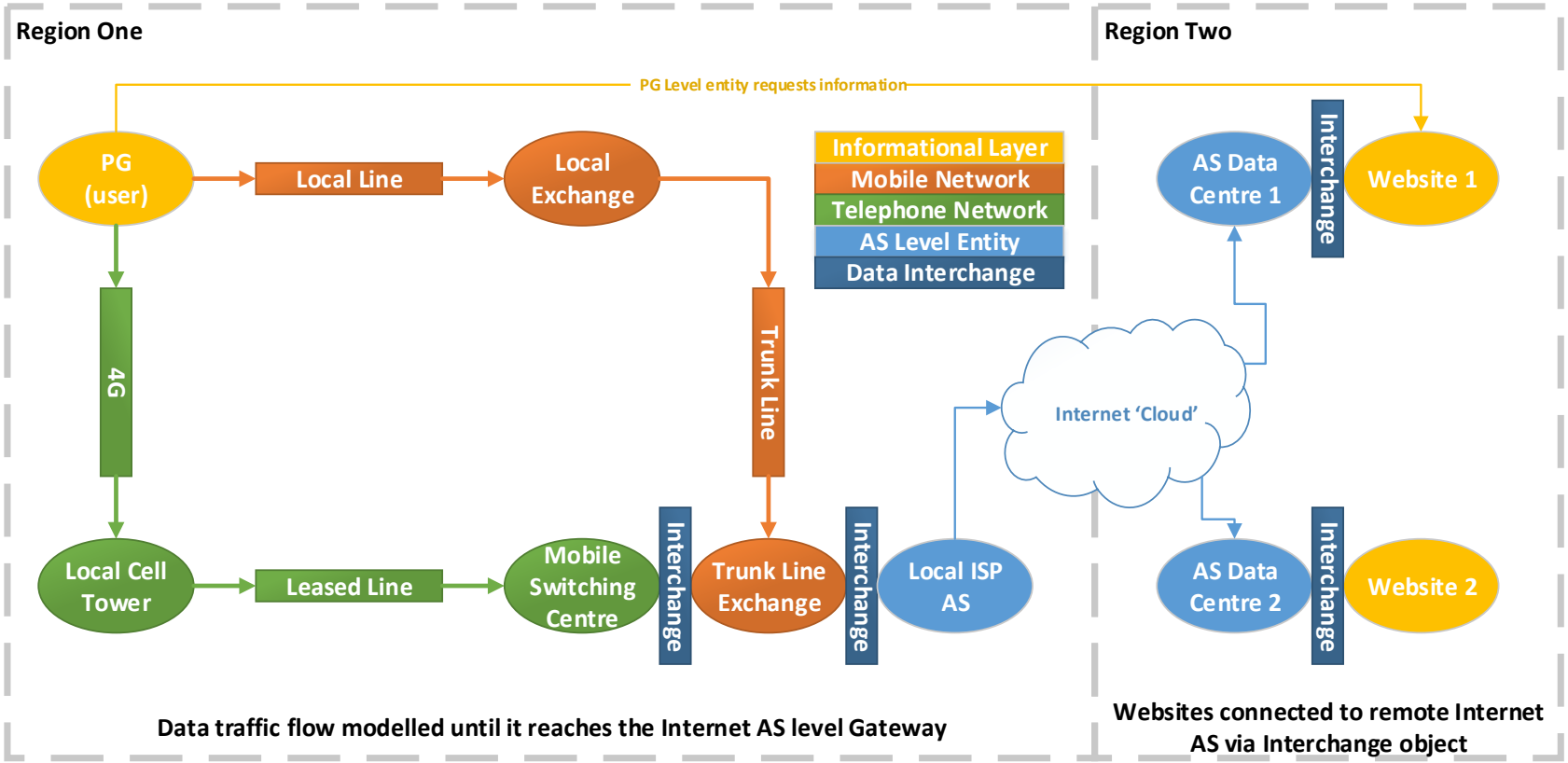
Labyrinth (2010) - The War On Terror 2001-2010.
The Awakening (2016) - The War On Terror 2010-2016.

Transport Modes

- Public data did not support original assumptions that disruption to public transport would change population flows.
- Public transport not a significant factor for test area (Southampton).
  - Car transport over 85% of region-region transport.
  - Non car transport only critical for areas like Inner London (84%).
- Difficulty in obtaining age distribution data to match transport model.

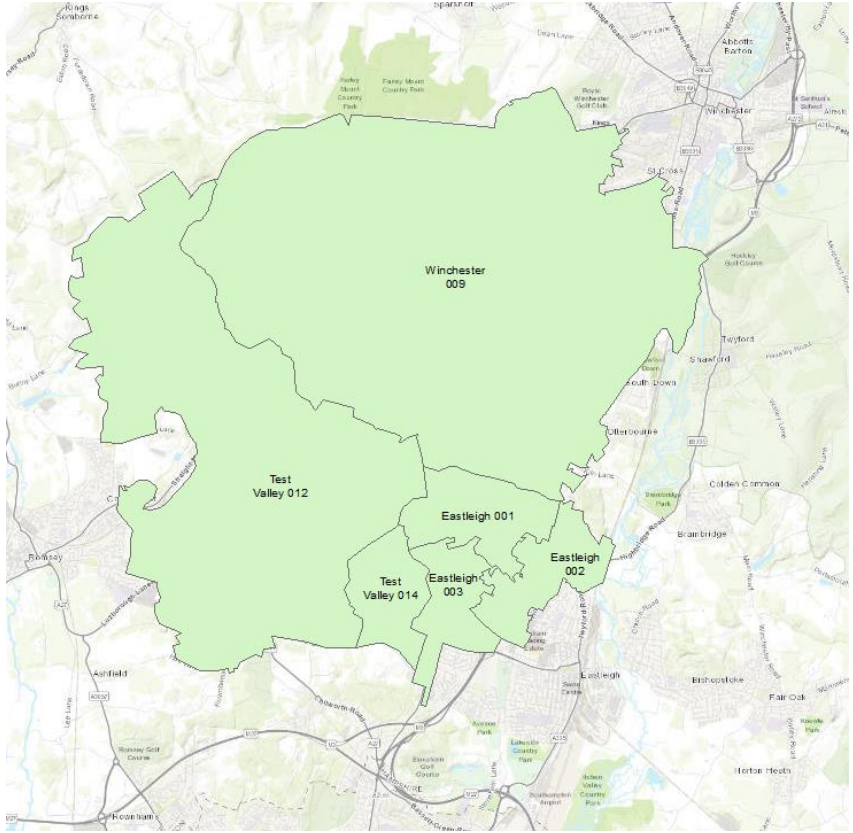
Region of residence	Car	Motorbike	Bicycle	Bus/coach	Rail	Walk	Other
London	29	1	6	15	38	10	1
Inner London	14	2	10	17	42	13	2
Outer London	39	1	3	13	36	8	1
South East	71	1	4	4	10	10	1
South West	74	1	5	5	2	14	1
East of England	70	1	4	3	11	10	1

Modelling the Internet



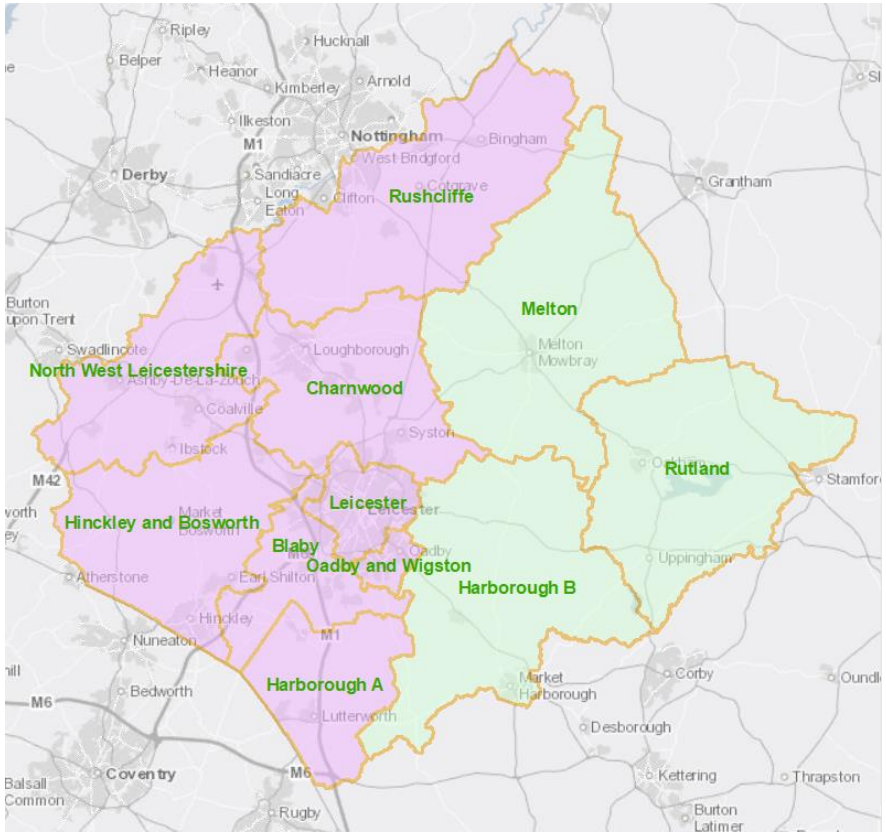
Sample - Chandlers Ford

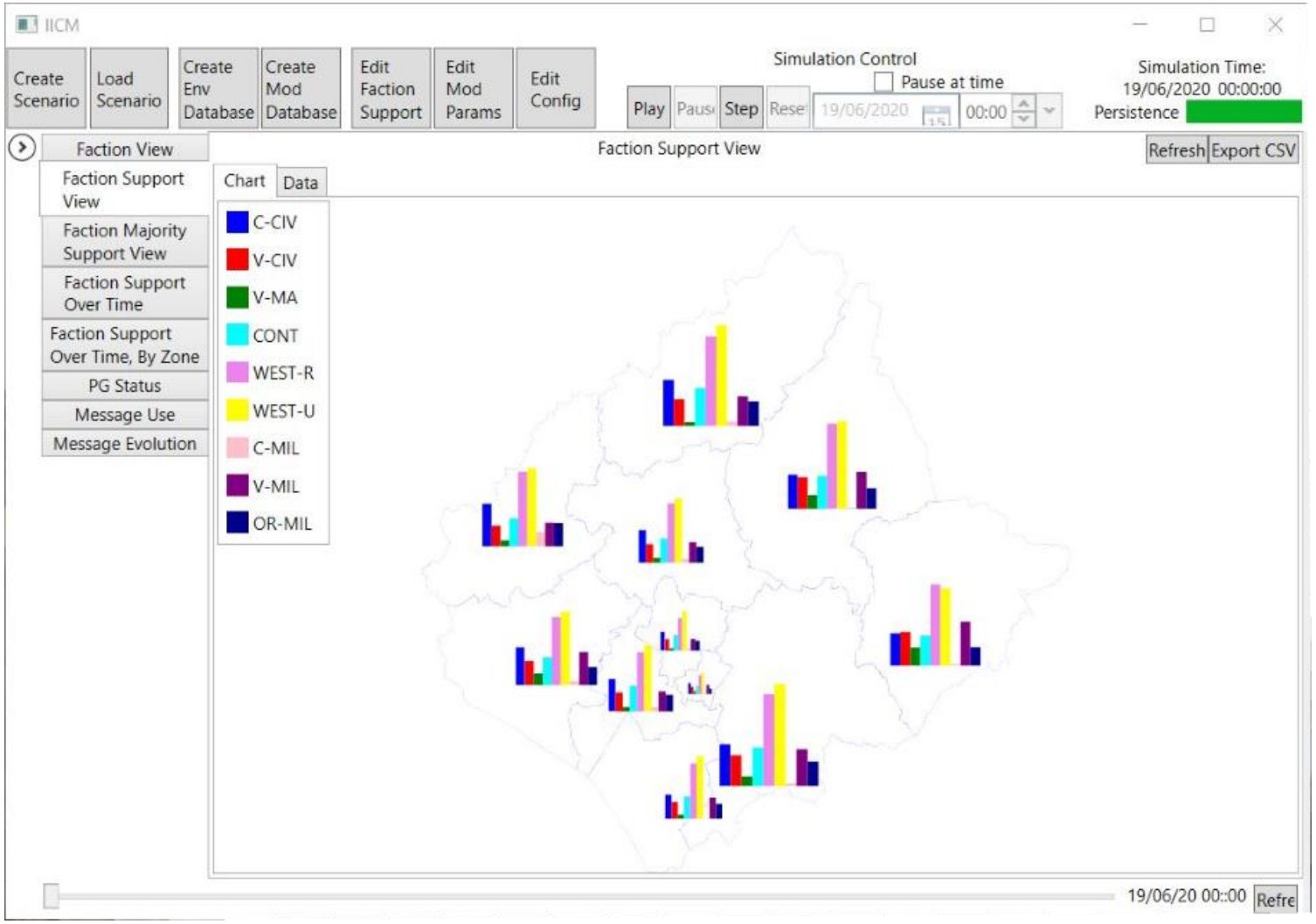
- 6 Districts.
- 55K Population.
- Rural and Urban mixture.
- Road transport links.
- 5 Factions: -
  - Rural Civil.
  - Urban Civil.
  - Government.
  - Farm Workers Union Insurgents.
  - Military Forces.
- Tactical level exercise.



Sample – Adept Cormorant (ACSC)

- 11 Districts.
- 350K Population.
- Rural and Urban mixture.
- Road transport links.
- 9 Factions: -
  - CIN Civil Nationalists
  - VED Civil Nationalists
  - Local Militia
  - Continentals (Immigrant)
  - Westrian Rural (Local Ethnic)
  - Westrian Urban (Local Ethnic)
  - CIN Military
  - VED Military
  - ORL Military
- Operational level exercise.




IICM
Create Scenario
Load Scenario
Create Env Database
Create Mod Database
Edit Faction Support
Edit Mod Params
Edit Config
Simulation Control
Pause at time
Play
Pause
Step
Reset
19/06/2020
00:00
Simulation Time:
19/06/2020 00:00:00
Persistence
Faction View
Faction Support View
Faction Majority Support View
Faction Support Over Time
Faction Support Over Time, By Zone
PG Status
Message Use
Message Evolution
Faction Support View
Refresh
Export CSV
Chart
Data
C-CIV
V-CIV
V-MA
CONT
WEST-R
WEST-U
C-MIL
V-MIL
OR-MIL
19/06/20 00::00
Refre

Selected Biography

- Out of the Mountains: The Coming Age of the Urban Guerrilla by David Kilcullen (2015)
- The Logic of Violence in Civil War (Cambridge Studies in Comparative Politics) by Stathis N. Kalyvas (2006)
- Mathematical Modelling of Zombies by Robert Smith?
- War in 140 Characters: How Social Media Is Reshaping Conflict in the Twenty-First Century by David Patrikarakos (2018)
- BBC Four Pandemic Model ‘Haslemere dataset’ (2018).