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IICM Human Terrain Modelling

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Connections UK 2019

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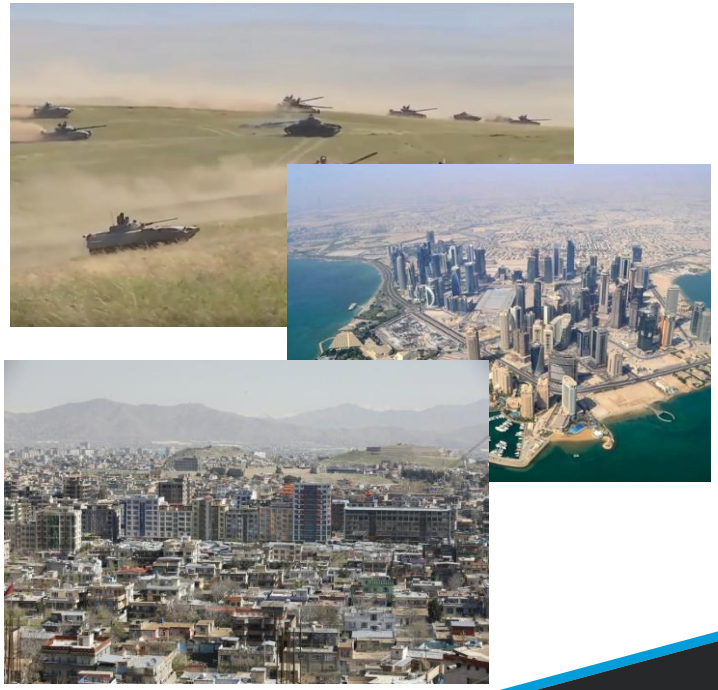
Next Generation Simulations…

Require 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.



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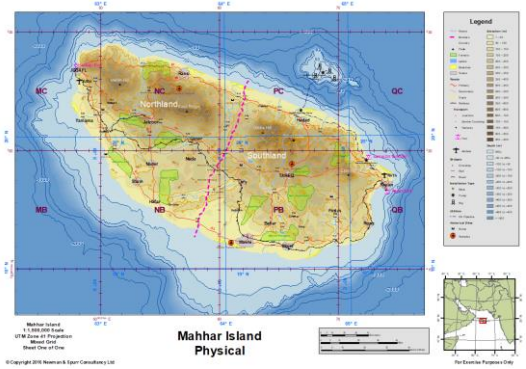
Human Terrain Aspirations

A Human Terrain 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.



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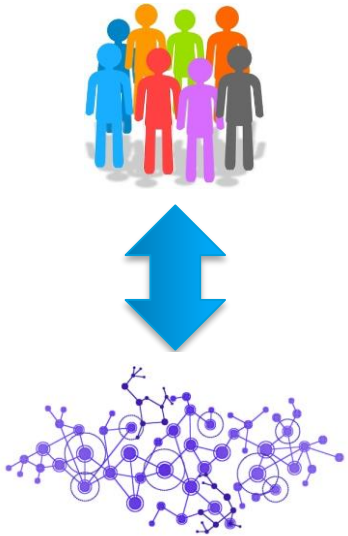
Influence and Infrastructure Combat Model (IICM)

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

- Explore the impact of Influence Operations and Cyber.
- 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.
- Indicative, not Predictive.



UK DSTL DASA program funded first of three expected project phases.

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

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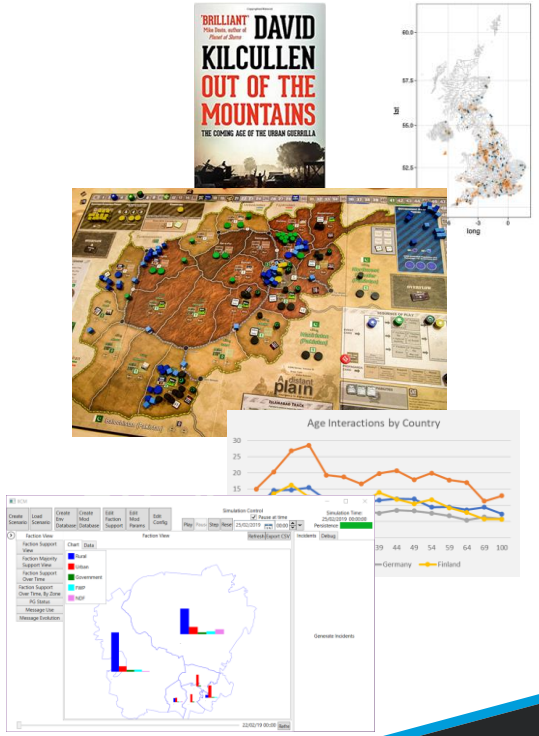
Project Methodology

- Review academic studies: -
  - Social Interaction models
  - Counter-Insurgency and Influence operations
  - Urban Modelling
  - Infectious Disease models
- Investigate COTS gaming solutions.
- 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.



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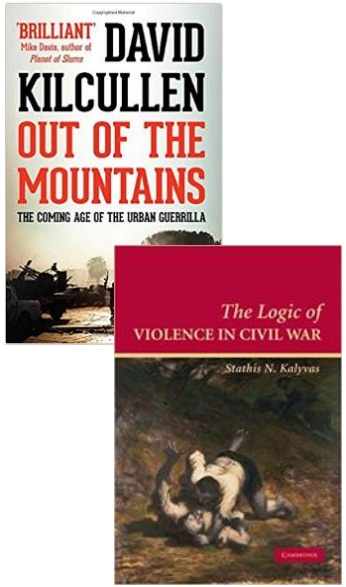
Urban Areas and Cities

- 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

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Contemporary Manual Wargames

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

Key design concepts

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

A Distant Plain (2013) – Afghanistan 2003-2013
Fire In the Lake (2014) - Vietnam 1964-1975
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.

Next War : Poland (2017)

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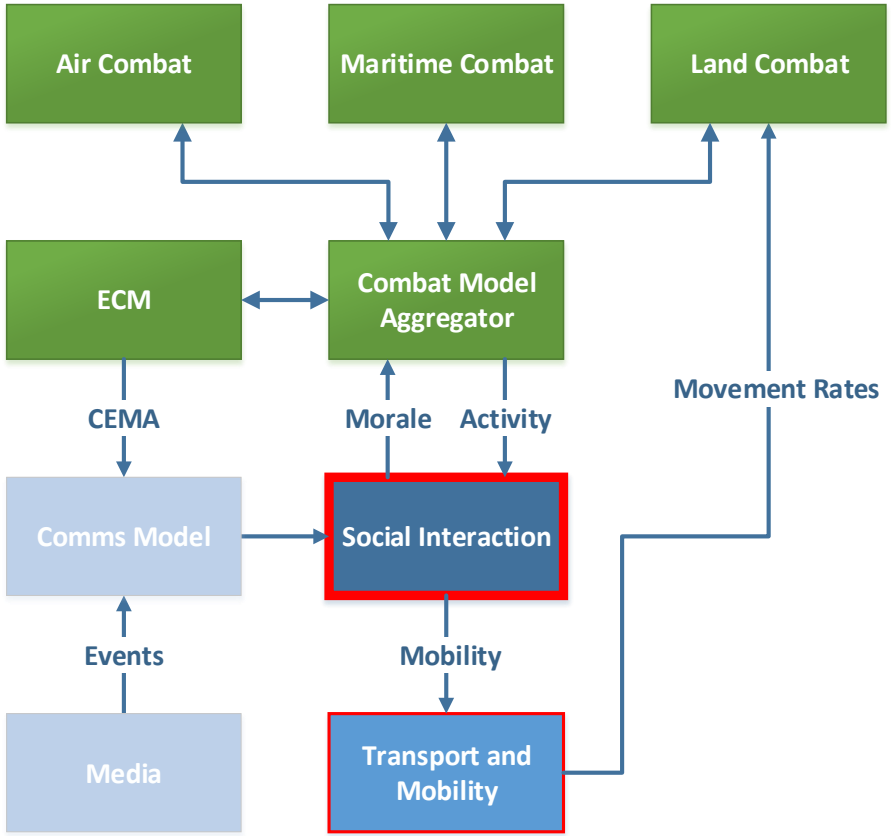
Key Model Features

- 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”.*



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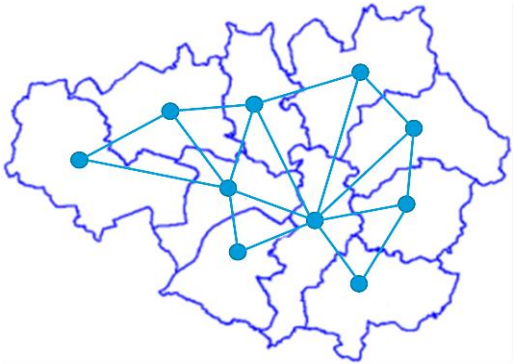
Social Model - Geography

Geographical building block of a scenario

- Map divided into areas based on administrative regions (allows use of Census data).
- Rural and Urban areas are separated. Use ‘Urban Terrain Zone’ (UTZ) classifications.
- Local road networks form underlying Arc-Node based transport network between adjacent Zones.
- ‘Control’ of region may contested by multiple groups.
- 10-20 Zones for a training model, more for an analytical model



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Social Model - Factions

Most competition is conducted by non-state actors (Factions).

Different Factions have different objectives: -

- Government = Preserve stability, maintain powerbase.
- Insurgents = Change the political system
- Security Agency = Information gathering and peace enforcement.
- Hactavists = Change governmental policy / accumulate social capital.
- NGO / NSA = Raise publicity for a cause, protect reputation.
- Industry = Encourage trade.
- Militia = Community defence.
- Criminal = Make money.
- Military Forces = Gain a tactical advantage.

Dynamic and dramatic tension between factions…

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Social Model - 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'*

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Social Model – Age and Culture

Germany

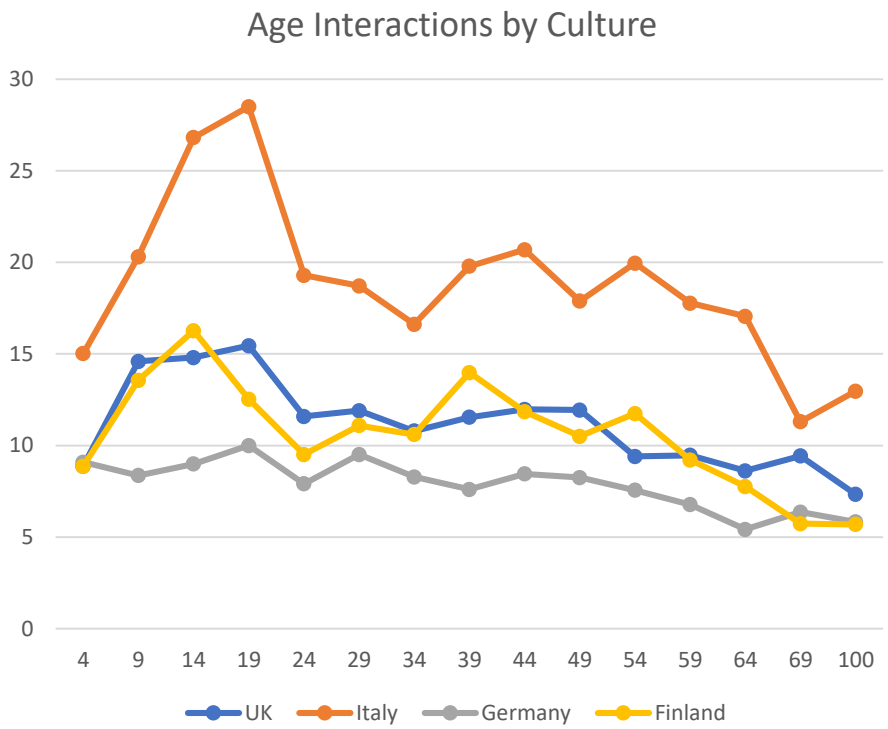
Age	00-09	10-19	20-29	30-49	50-64	65+	SUM
00-09	2.66	0.33	0.28	1.01	0.41	0.24	**4.92**
10-19	0.90	4.70	0.73	2.38	0.47	0.58	**9.75**
20-29	0.93	1.08	3.48	1.96	1.18	0.44	**9.05**
30-45	1.57	1.16	1.28	3.98	1.59	0.93	**10.50**
45-64	0.60	0.65	0.96	2.01	2.22	0.87	**7.31**
65+	0.69	0.36	0.39	0.97	1.00	1.71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



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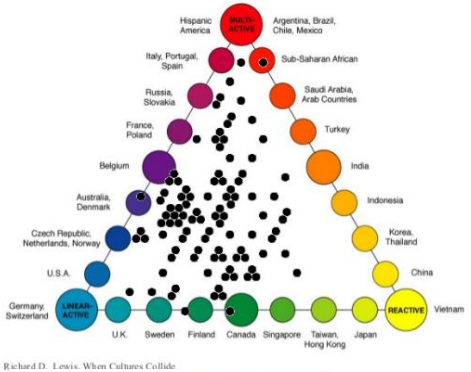
Social Model - Cultural Distance

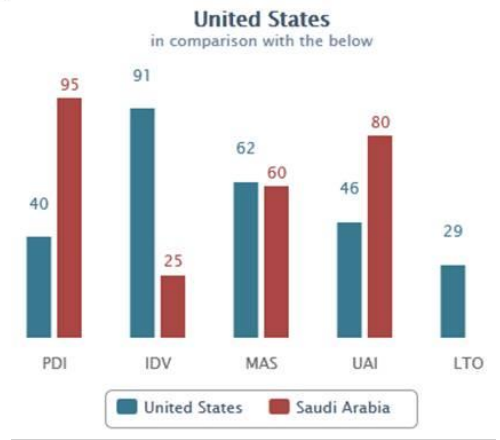
Measures the ability of groups to communicate with each other. Two models depending on the training audience: -

- Lewis 3 way model.
  - 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).
  - 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



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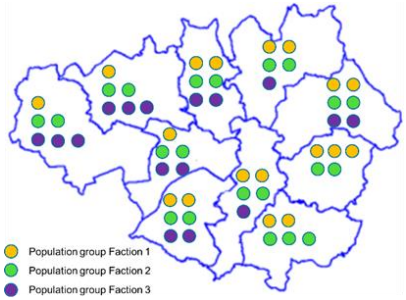
Social Model - Population Group

Social building block of a scenario

- Sub group of a population within a region.
- Shared faction, movement characteristics and age band.
- Have a daily activity cycle based on social interaction studies.
- Modelled by a Semi-Autonomous Software Agent.
- 10’s to 100’s of PGs per region.
- Optional non geographic groups to represent Diaspora.



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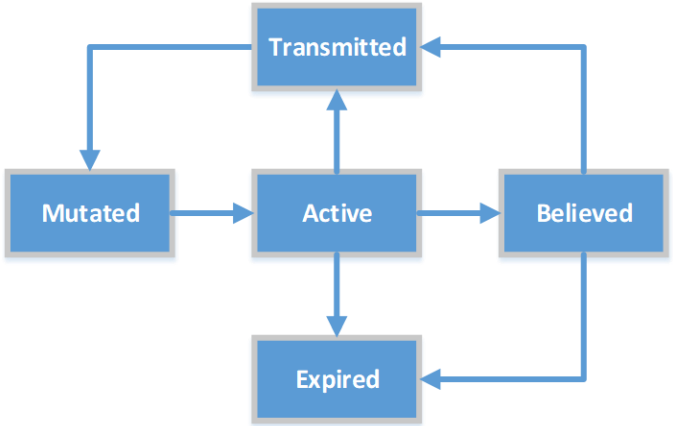
Message Model

Messages are memes: -

- Encode change in support for a faction (sentiment).
- Modelled as software agents that replicate through a human terrain.
- ‘Cultural Distance’ limits message transmission and comprehension.
- Messages distort and evolve as they are transmitted.
- 10’s of messages per PG, 1000’s of unique messages in a running scenario.



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Population Group Behaviour

- A PG measures support for all factions, including its own. Messages change these values.
- PGs travel between regions but have a default Home and Work region where most interactions take place.
- A PG holds a list of active ‘messages’ that are exchanged when they interact with each other.
- Social Media effects applied by an hourly ‘smoothing model’.

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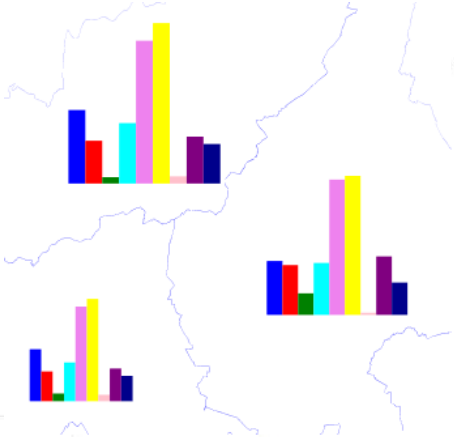
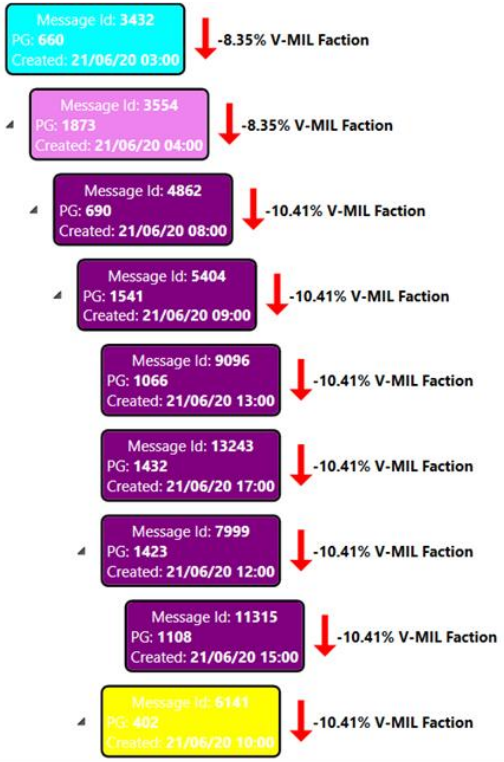
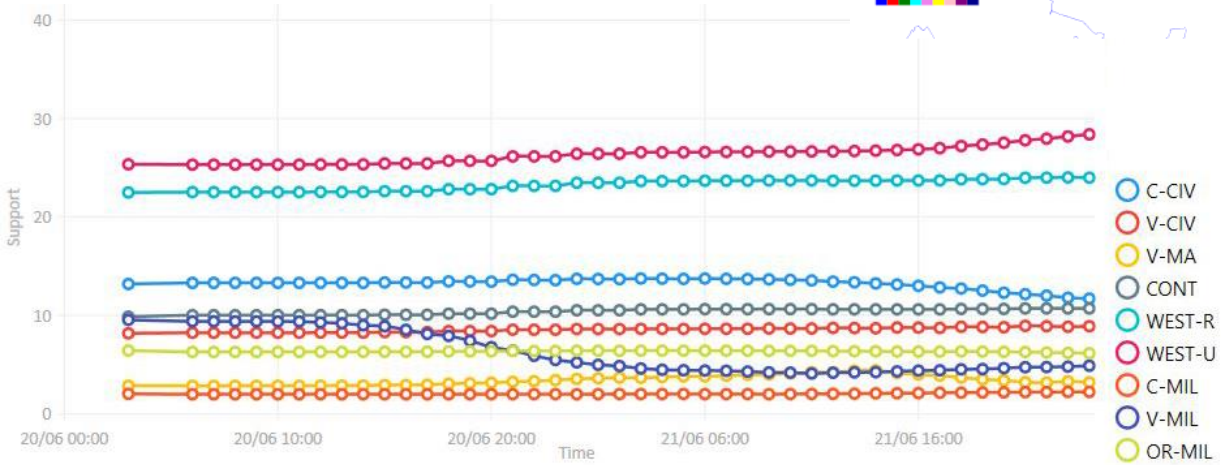
Model Outputs

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

SQL Database to allow data mining…







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Conclusions

- Demonstrated information flow through a Human Terrain.
- Model suitable for both manual and computer assisted wargames.
- Census and infection modelling data provides a useful base dataset that does not require Social Media derived databases.
- Computerised 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

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QUESTIONS?

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SPARE SLIDES

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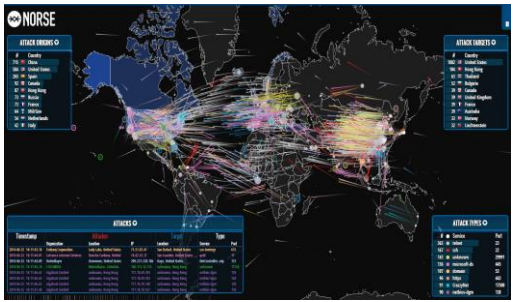
The Tactical ‘Hybrid’ gap

Military or Civil

- Staff – General awareness training (Cyber, Personal Security)…
- Systems Operators – How to operate specialist equipment…
- **Tactical Commanders – Consequences of Hybrid operations…**
- Operational Commanders – Campaign Objectives, ROE
- Strategic Commanders – Define Doctrine, Strategic Goals



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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

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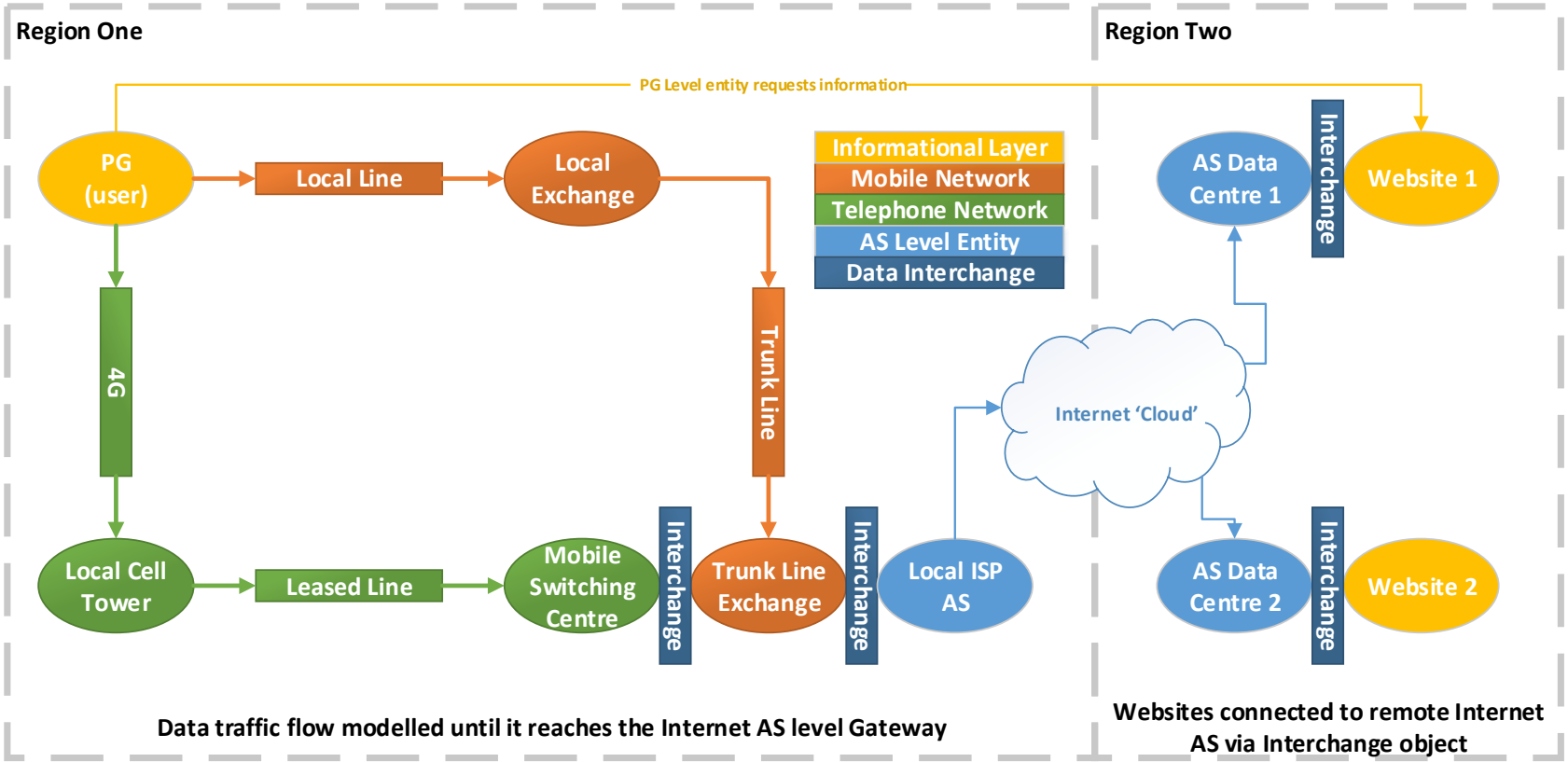
Modelling the Internet



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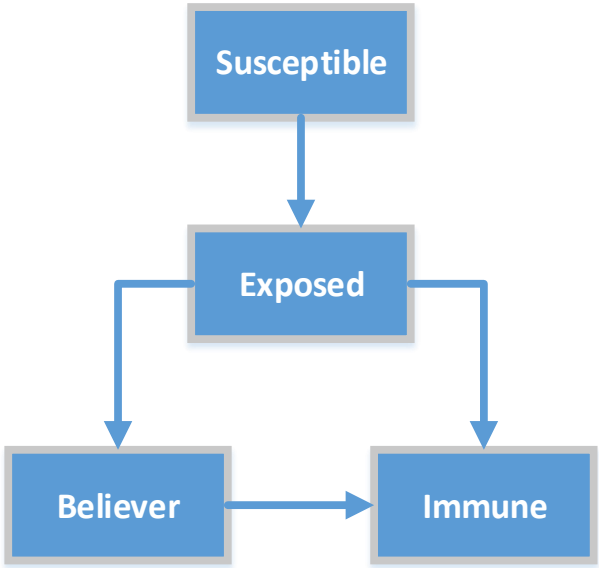
Compartment Models

A set of models used to simulate the spread of infectious diseases.

- SEIR (Susceptible, Exposed, Infected, Recovered) type population states.
- 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.



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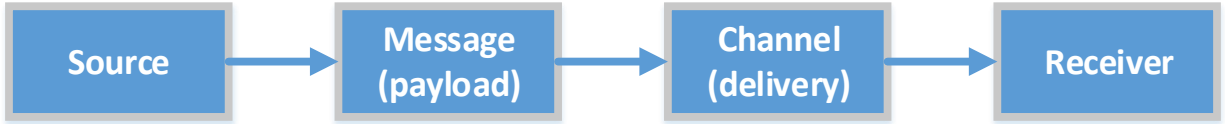
Message Model - 1

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.

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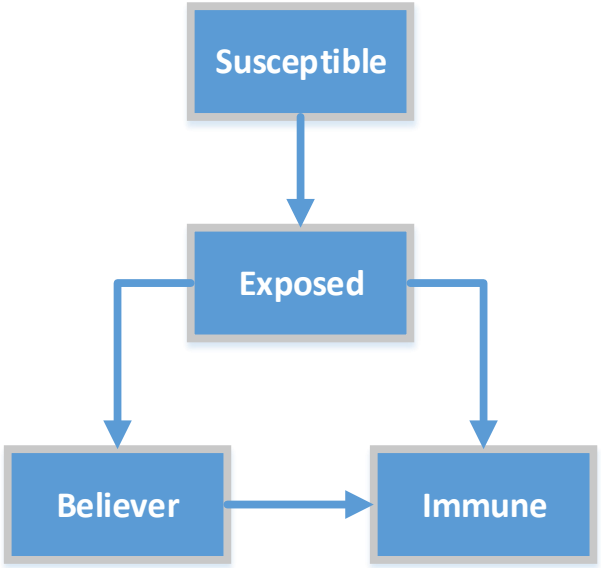
Message Model - 2

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.



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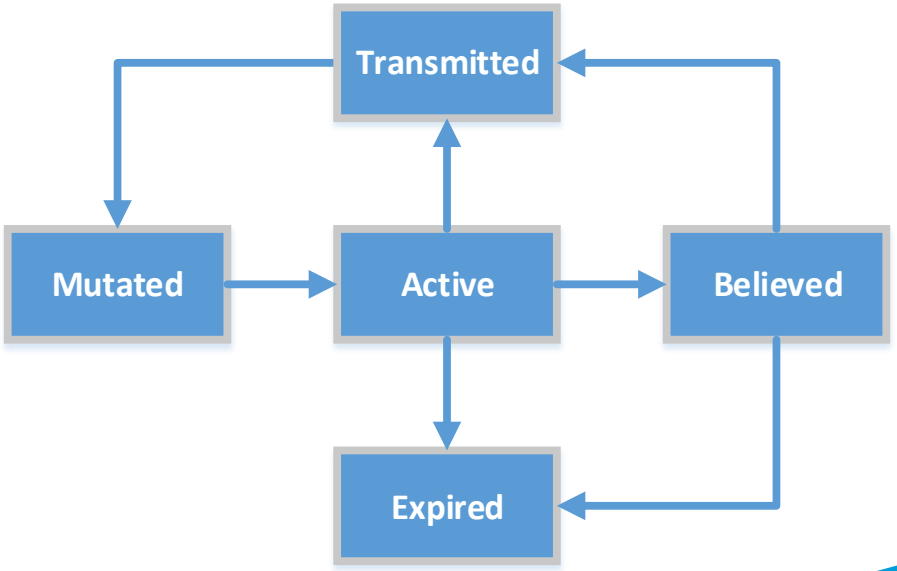
Message Model - 3

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.



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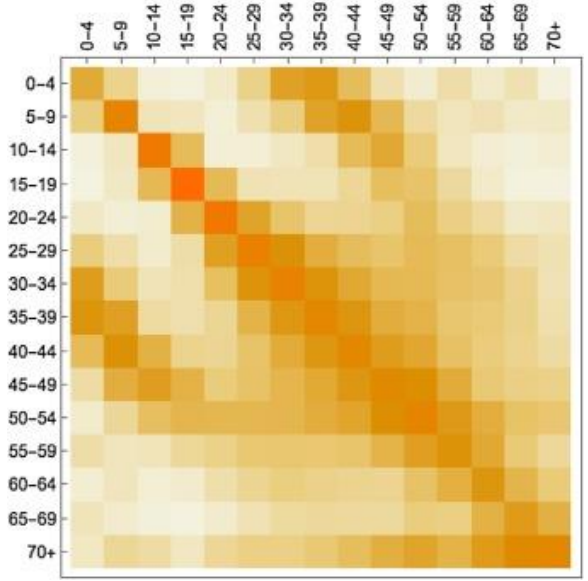
Population Age Communication Factors

Age of an individual affects the chance of social interaction (POLYMOD dataset).

- 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

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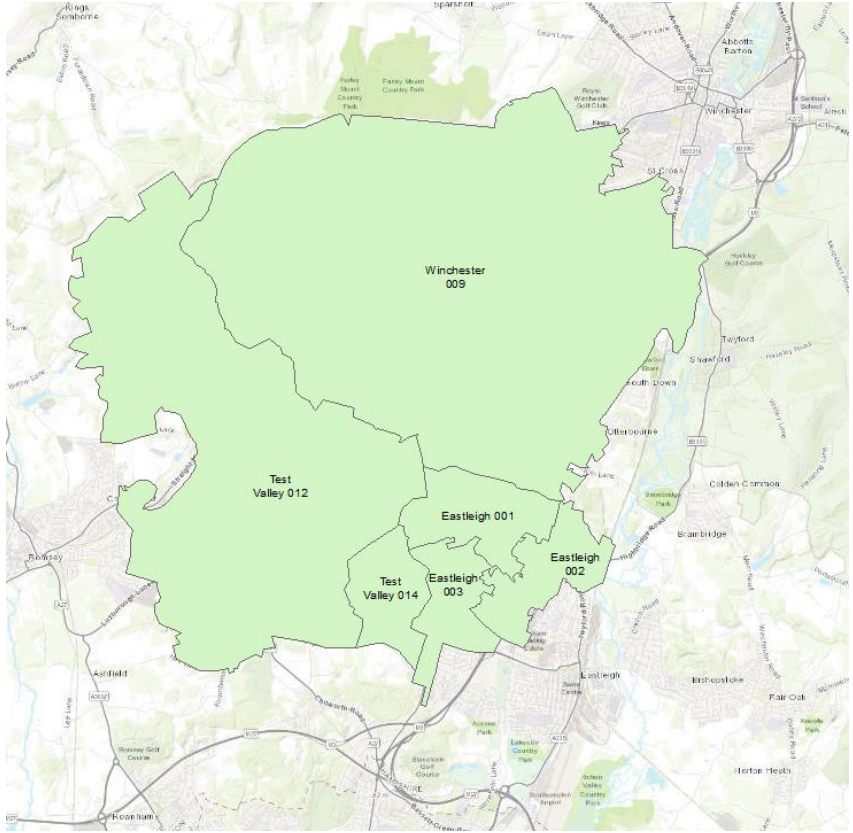
Sample - Chandlers Ford

- 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.



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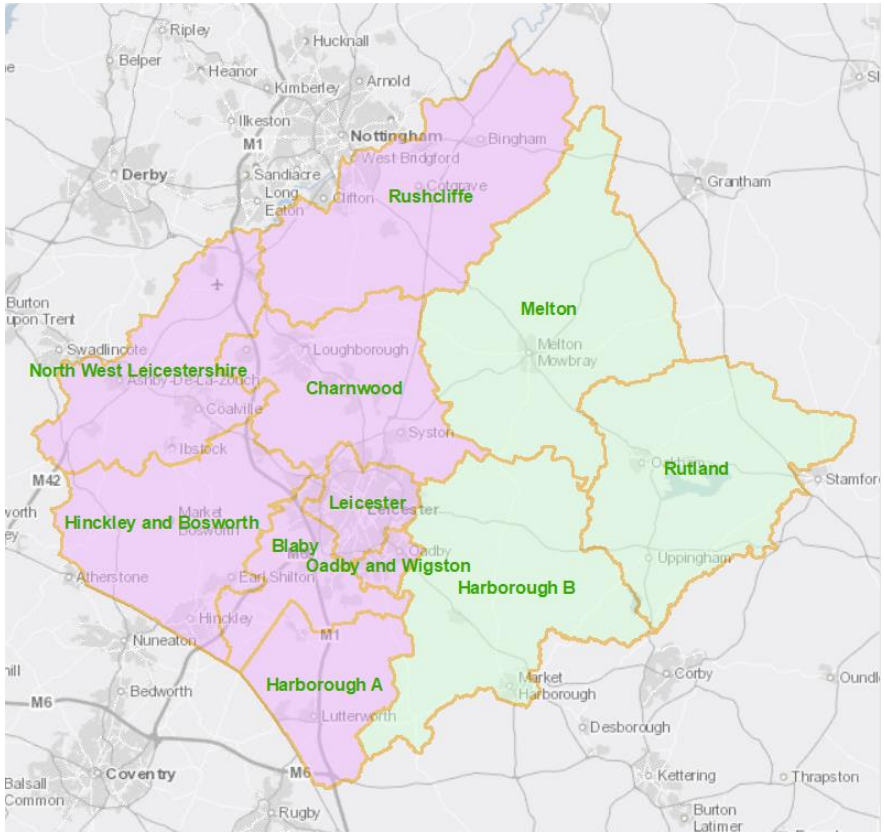
Sample – Adept Cormorant (ACSC)

- 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.



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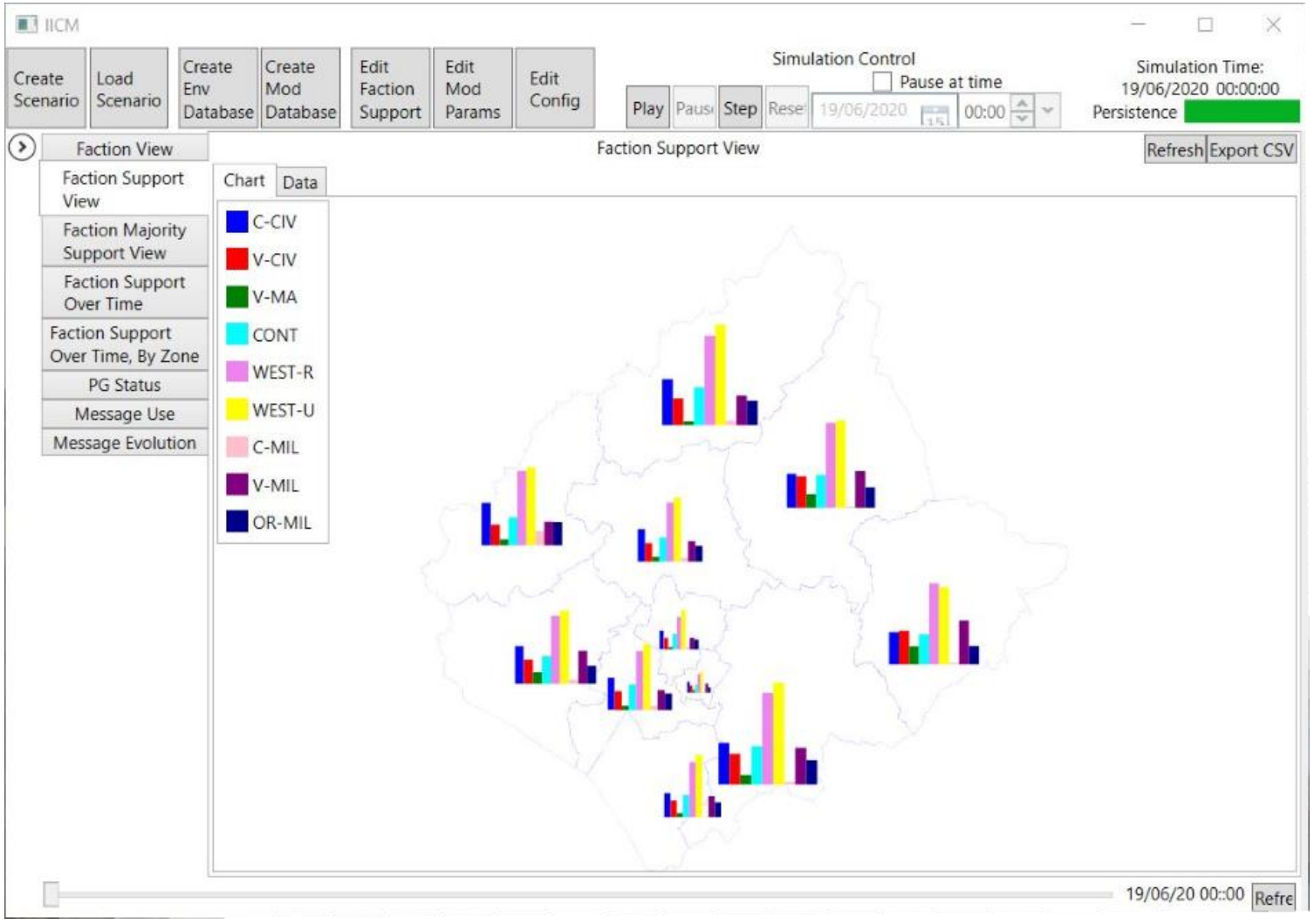
IICM
Create Scenario
Load Scenario
Create Env Database
Create Mod Database
Edit Faction Support
Edit Mod Params
Edit Config
Simulation Control
Pause at time
Play
Pause
Step
Reset
19/06/2020
00:00
Simulation Time:
19/06/2020 00:00:00
Persistence
Faction View
Faction Support View
Faction Majority Support 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
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V-CIV
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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)
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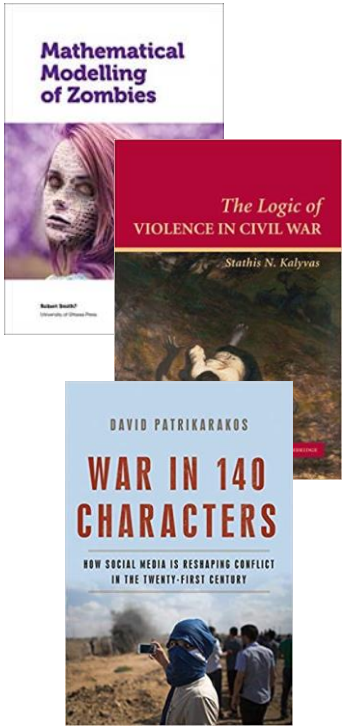

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