COURSE OF ACTION ANALYSIS USING TIMED INFLUENCE NETS

Pythia

Pythia Demonstration

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Adversary Behavioral Modeling
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OUTLINE

- Objective
- Tool
- Model
- Demo
- Process for Course of Action Analysis
- Conclusion

OBJECTIVE

- **Create a capability to allow rotating and in-country forces to easily and quickly access data and *knowledge* about the cultural landscape of there area of operation that can be used to support their understanding of the *key issues, beliefs, and reasoning concepts* of the local culture**
- **Need: Given a military objective and a set of desired effects derived from statements of commander's intent, develop and analyze alternative courses of actions (COAs) that will cause those desired effects to occur and thus achieve the military objective.**
- **Approach: Timed Influence Net technology (developed with support from ONR, AFOSR and AFRL)**
  - **A case study approach to demonstrate how the *tool* and *a process* using the tool can support the required capability.**
  - **Case study issue: How to suppress IEDs in a province in Iraq by reducing local support to the insurgents**

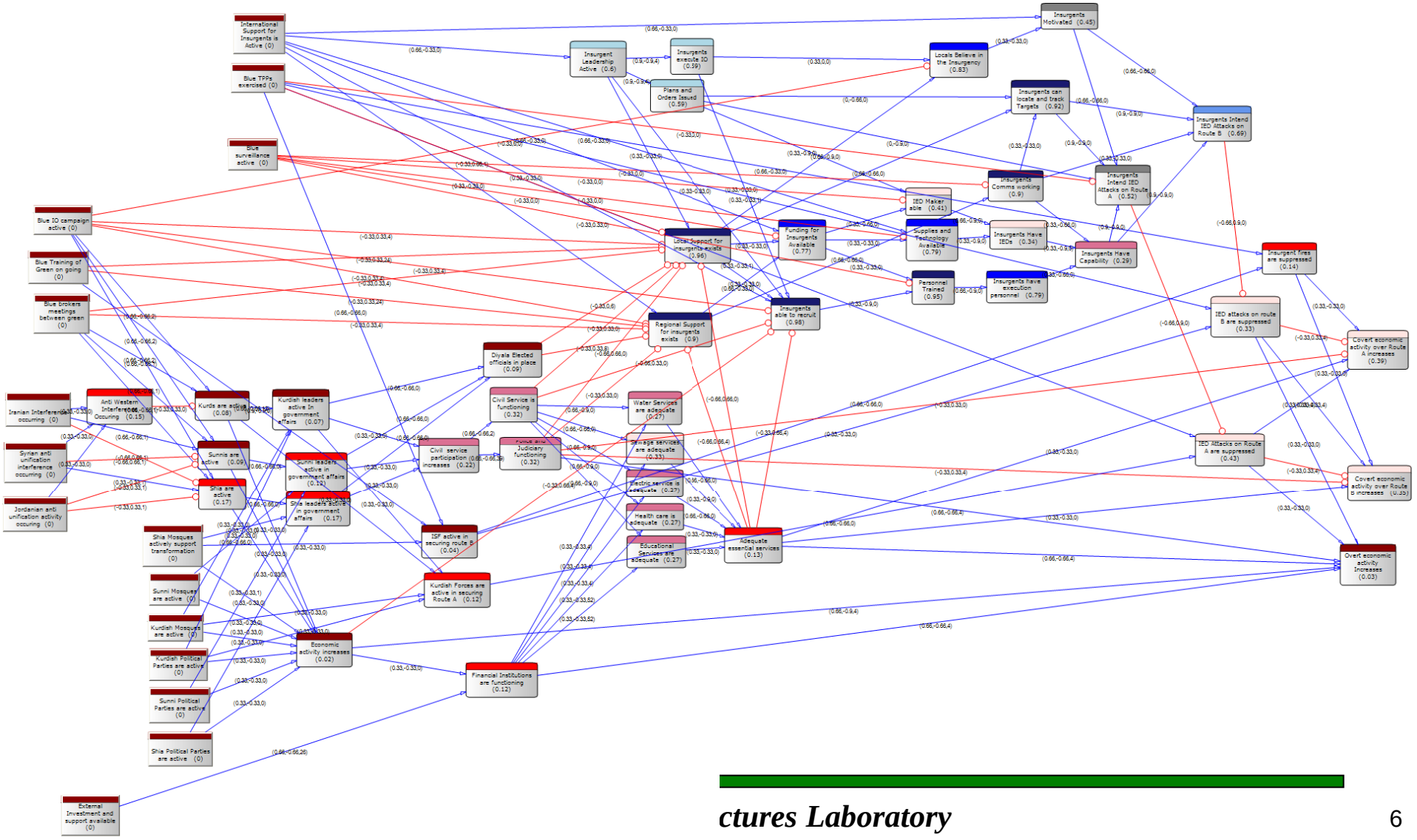
CASE STUDY SCENARIO

- The problem addressed suppression of the use of Improvised Explosive Devices (IEDs) in a specific province of Iraq, denoted as province D
  - Specifically, it is assumed that IED incidents have increased along two main east-west routes between the capital town C of the province and a neighboring country M
- There were hundreds of documents about Iraq in general and D province in particular that were reviewed to get a better understanding of the situation
  - Both roads are historically significant smuggling routes
  - The northern route was in the predominantly Kurdish region and the southern route was in a predominantly Shia region.
  - A dynamic tension existed between these regions particularly with regard to the flow of commerce because of the revenue the flow generates
  - Some revenue was legitimate, but a significant amount was not and was considered covert.
  - Increased IEDs in one region tended to suppress the trade flow in that region and caused the flow to shift to the other
  - Consequently, each region would prefer to have the IEDs suppressed in its region, but not necessarily in the neighboring region
  - The IED perpetrators needed support from the local and regional populations as well as outside help to carry out their attacks.

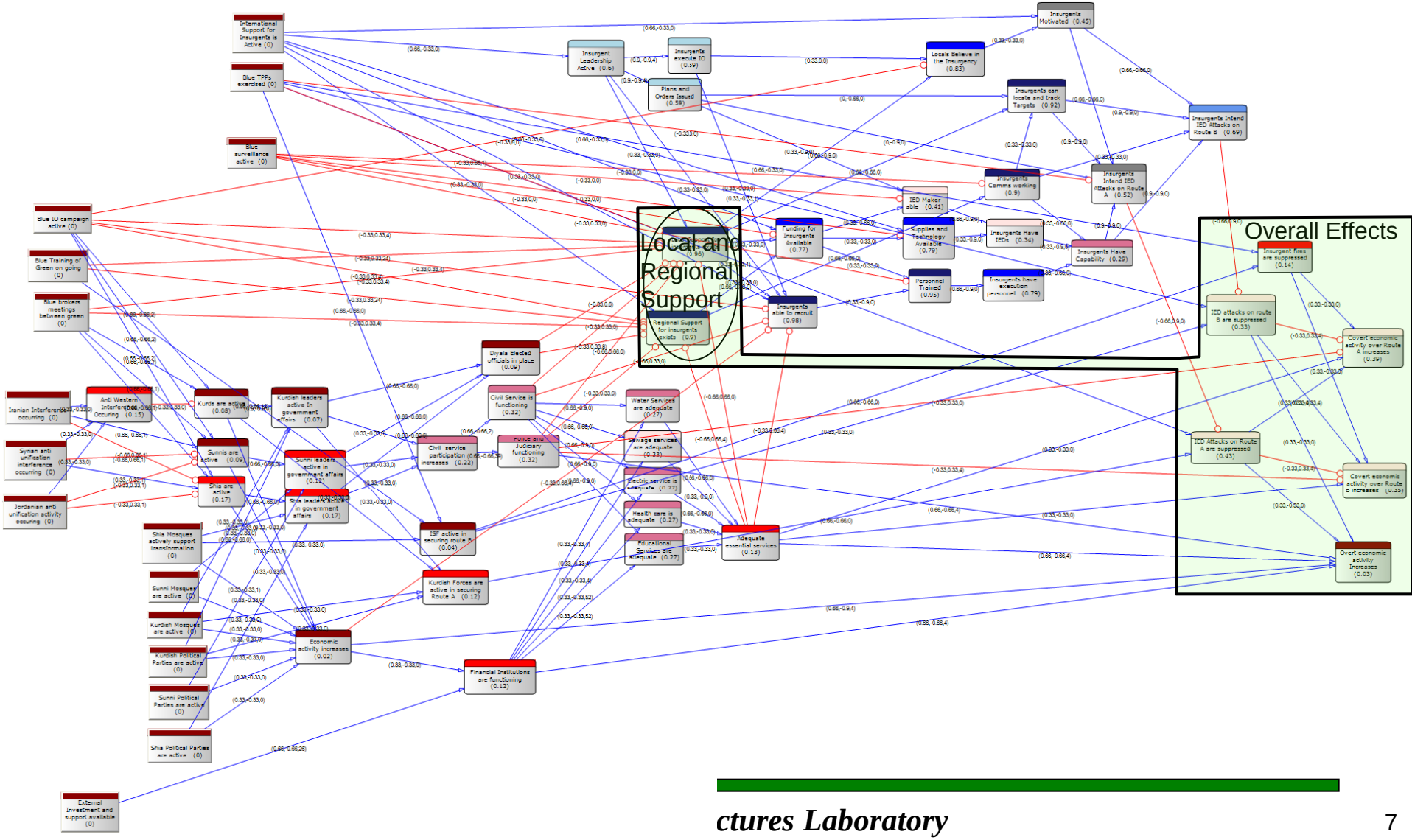
COA ANALYSIS PROCESS

- **COA analysis is done by a process that supports planning, execution, and assessment**
  1. **Determine the Desired and Undesired Effects**
  2. **Build probabilistic model(s) linking potential actions to those effects (and determine indicators that the effects have occurred)**
  3. **Use the probabilistic model to determine the best set of actions**
  4. **Incorporate temporal information and conduct temporal analysis to determine the sequence and timing of the actions and to determine them timing of ISR assets to check indicators**
  5. **Create detailed plan and execute collecting ISR information on indicators**
  6. **Use indicators to assess progress toward desired effects**
  7. **Repeat Sets 2 (perhaps 1) thru 6 as events unfold and new information is received**

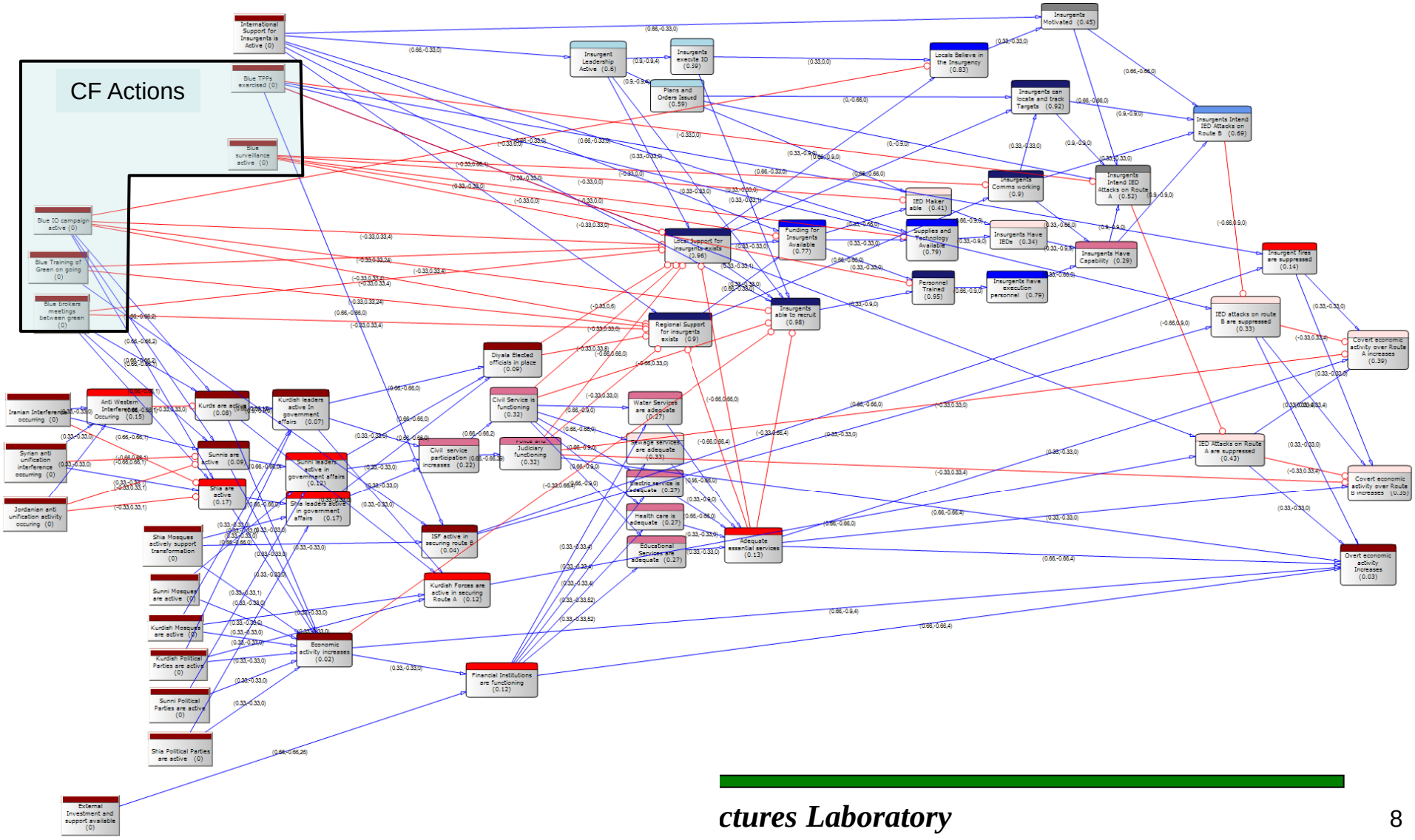
DEMONSTRATION MODEL



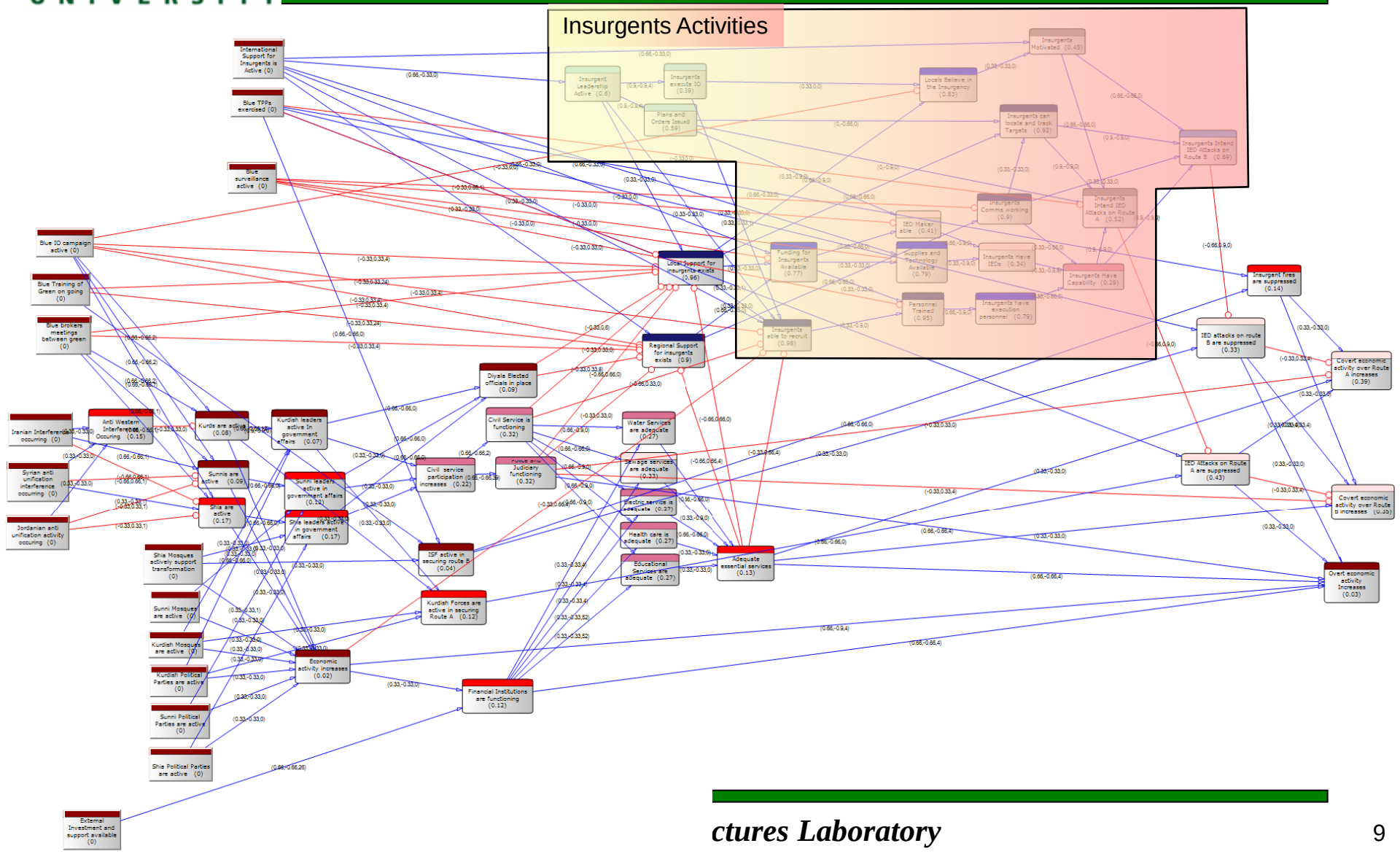
OVERALL EFFECTS



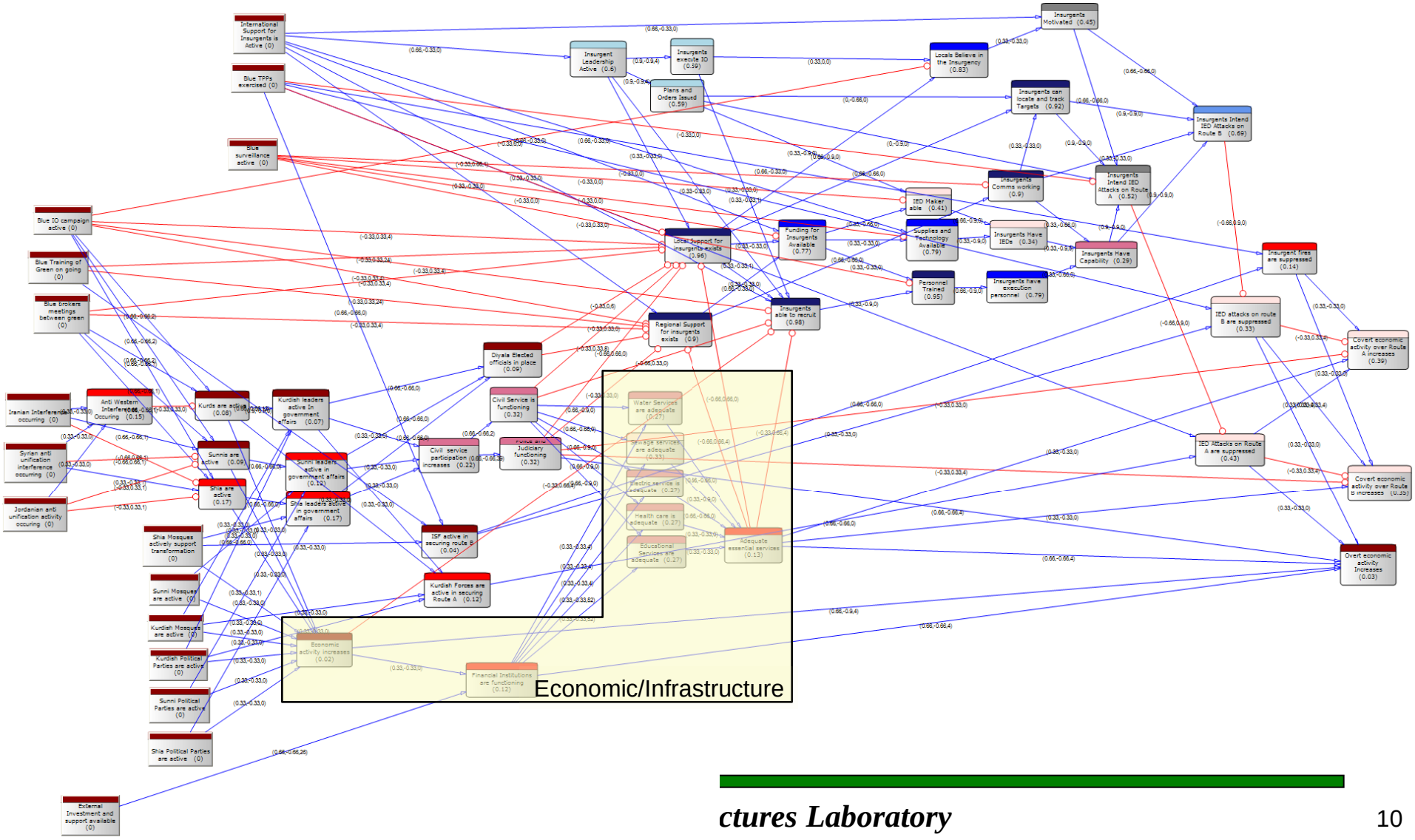
COALITION FORCE ACTIONS



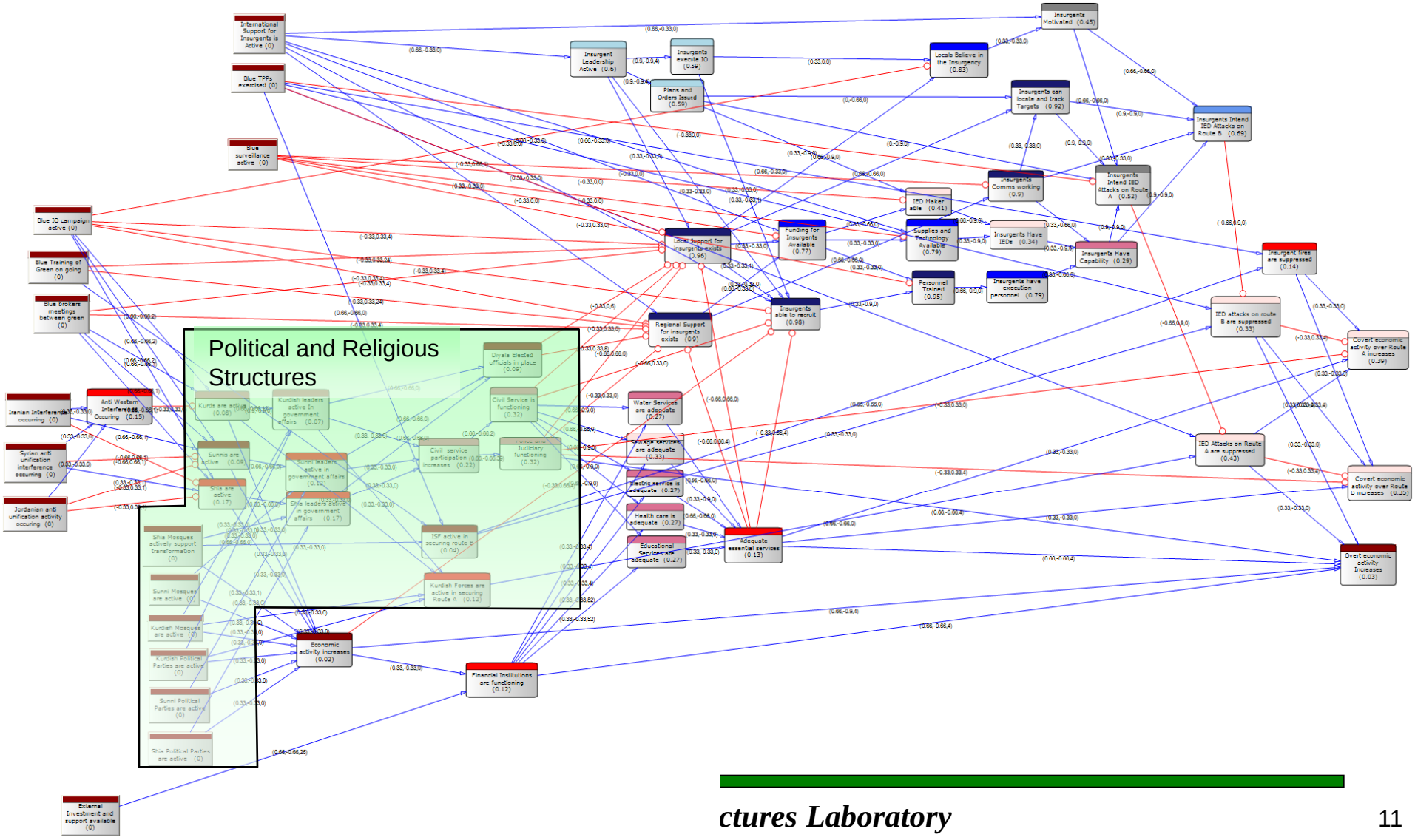
INSURGENT IED ACTIVITIES



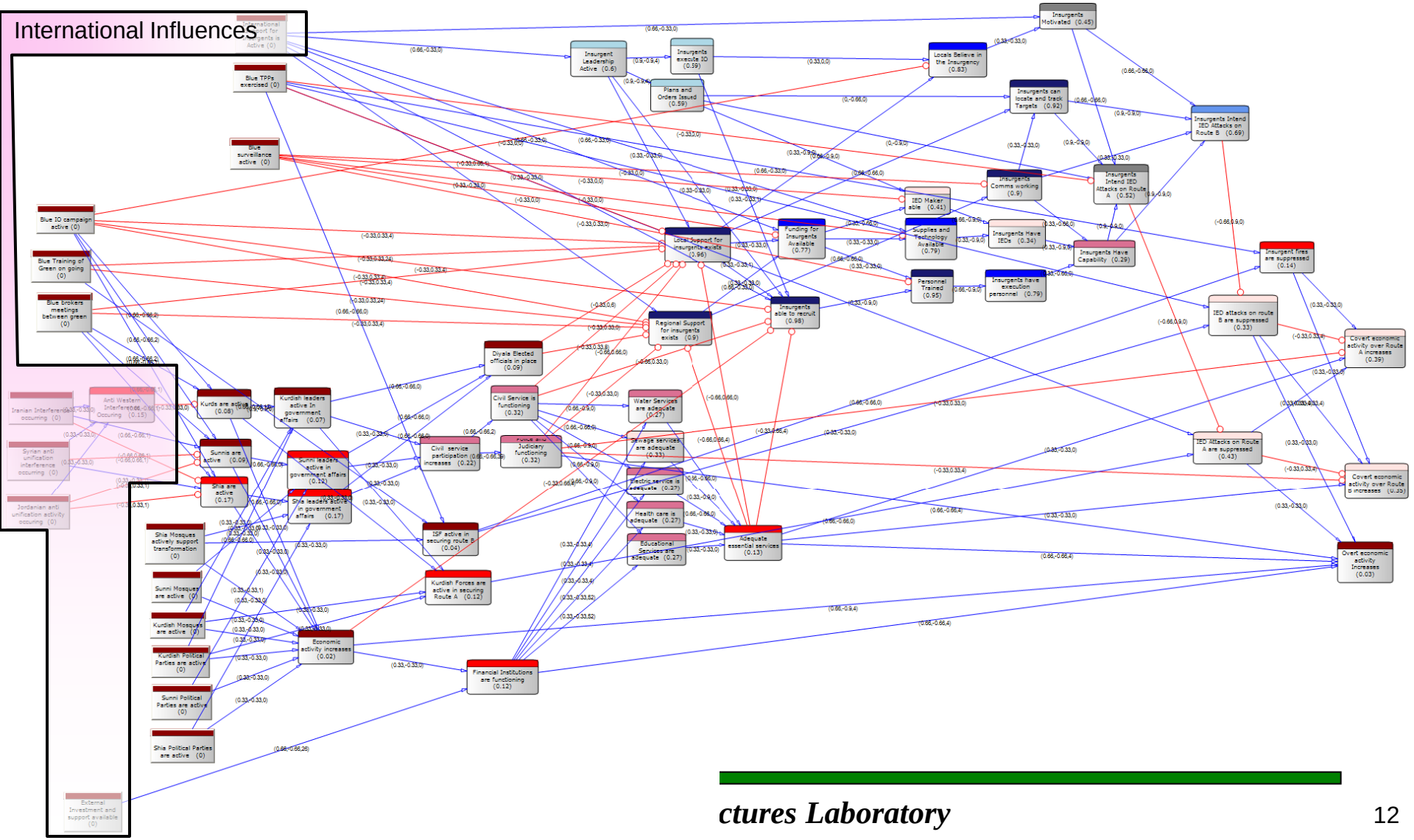
ECONOMIC/INFRASTRUCTURE



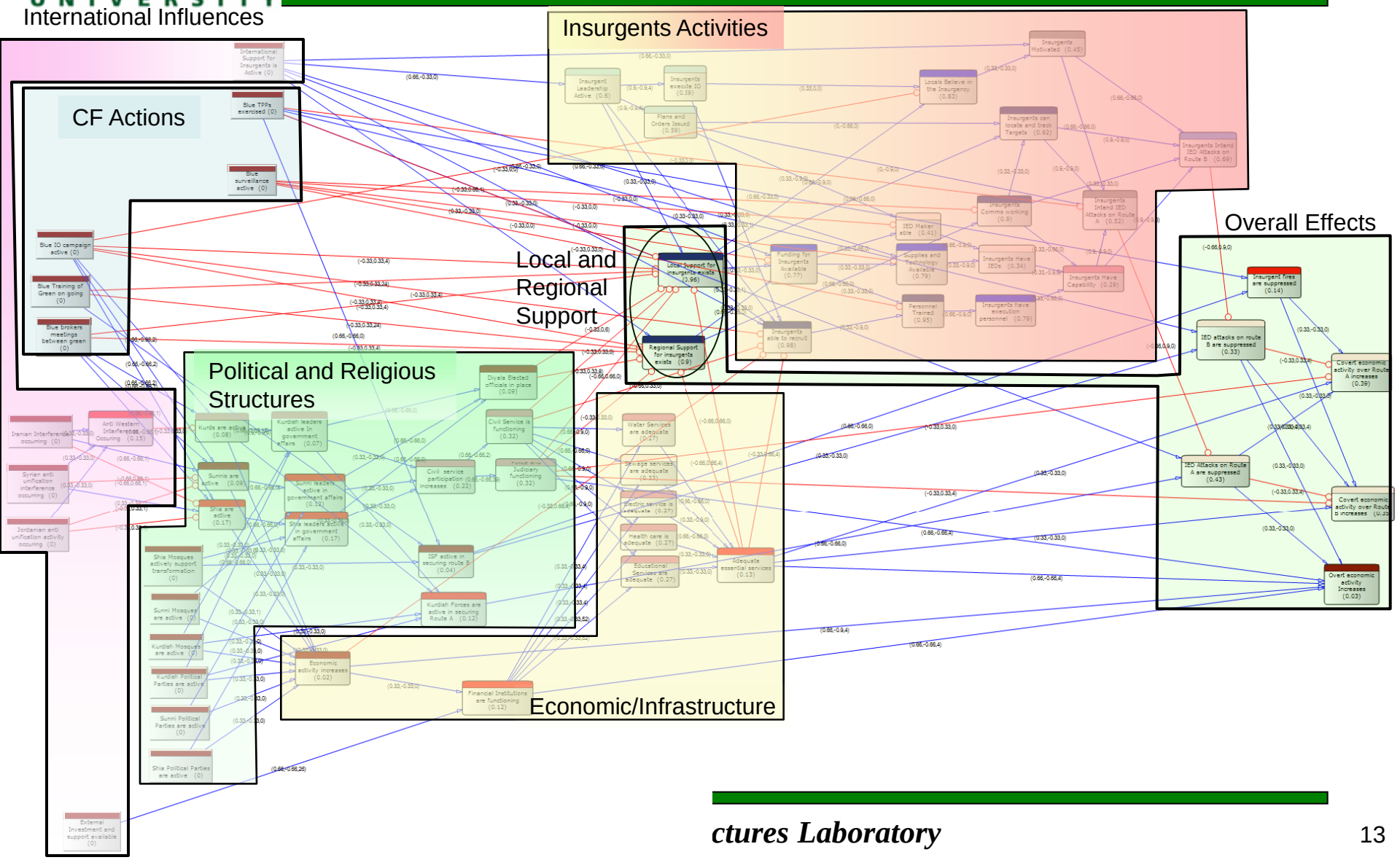
POLITICAL AND ENTHNORELIGIOUS FACTORS



INTERNATIONAL INFLUENCES



COMPLETE MODEL



RESULTS

- **Logical Level**
  - **Model captures complex causal and influencing relationships between Blue, Green, and Red beliefs, activities, and actions**
  - **Blue has some leverage, but other outside influences have major impacts on the situation**
  - **Model shows relationships between the actions and activities of major religious and ethnic groups and effects on government activities (police, judiciary, public works and service, etc.)**
  - **Model shows impact of the adequacy of government and public services on support of insurgency**
  - **Model captures the IED development planning and employment processes and the impact of the other activities, the status of public services, and coalition interventions on those processes**
  - **Model capture interaction of IED attack suppression on two major trade route roads (suppressing one route increases attacks on the other)**

RESULTS (STATIC QUANTITATIVE)

- **Adding strengths of influences and baseline probabilities allows calculation of the likelihood of actions and effects given selected actions**

EFFECTS	Situation (COA) 1	Situation (COA) 2	Situation (COA) 3	Situation (COA) 4
Local and Region Support Exists	0.97	0.92	0.26/0.36	0.22/0.14
IED Attacks Suppressed on Route A / B	0.17/0.15	0.31/0.34	0.67/0.68	0.85/0.74
Insurgent's fires suppressed	0.14	0.65	0.9	0.93
Public services adequate	0.12	0.39	0.39	0.55
Overt Economic Activity Increasing	0.02	0.08	0.31	0.89
Covert Economic Activity Increasing along routes A and B	0.37	0.50	0.56	0.57

	Sit (COA) 1	Sit (COA) 2	Sit (COA) 3	Sit (COA) 4
International Interference	X	X	X	X
External Financial Support		X	X	X
CF TTPs and Surveillance		X	X	X
CF IO, training, brokering			X	X
Iraqi political and religious group participation				X

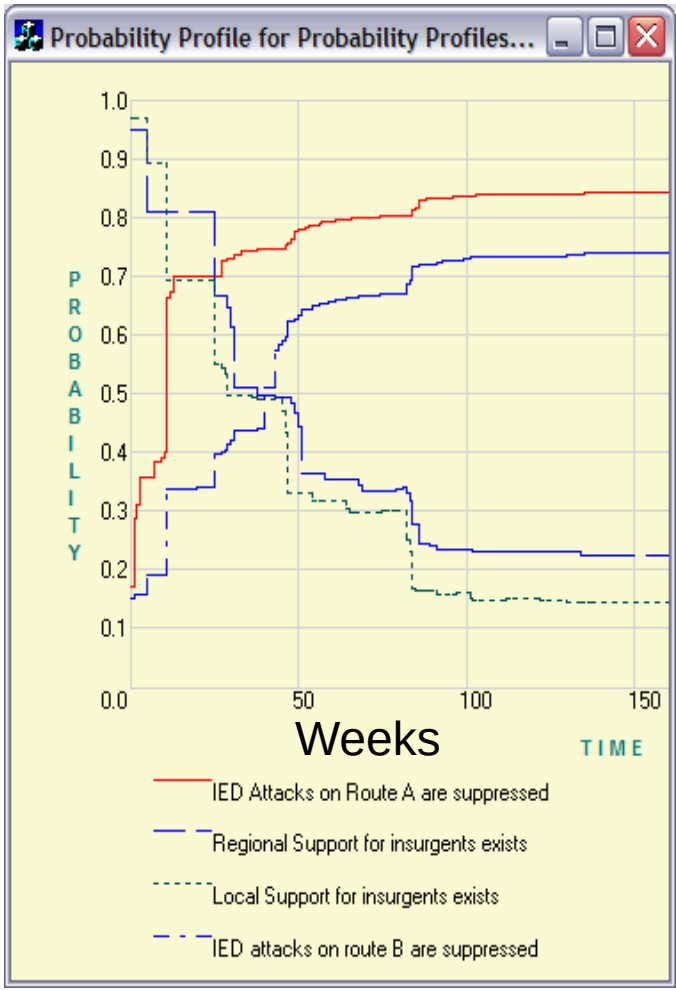
RESULTS (STATIC QUANTITATIVE)

- Convert the IN to a TIN by adding time delays to the arcs and nodes
- Select a COA by assigning Times to the actions

	Action	COA 4a: List [p, t]
Scenario Actions	Int'l Support to Insurgents	[1.0, 0]
	Interference by countries M and L	[0.5, 0], [1.0, 1]
	Interference by country S	[1.0, 0]
COA Actions	Blue TTPs activated	[0, 0], [1.0, 1]
	Blue Surveillance, IO, Training, Brokering	[0, 0], [1.0, 1]
	Shia and Sunni Religious Activity	[0, 0], [0.5, 10], [1.0, 20]
	Kurd Religious Activity	[0, 0], [1.0, 1]
	Kurd and Shia Political Activity	[0, 0], [1.0, 1]
	Sunni Political Activity	[0, 0], [1.0, 20], [0.5, 30], [1.0, 40]
	International Investment	[0, 0], [1.0, 26]

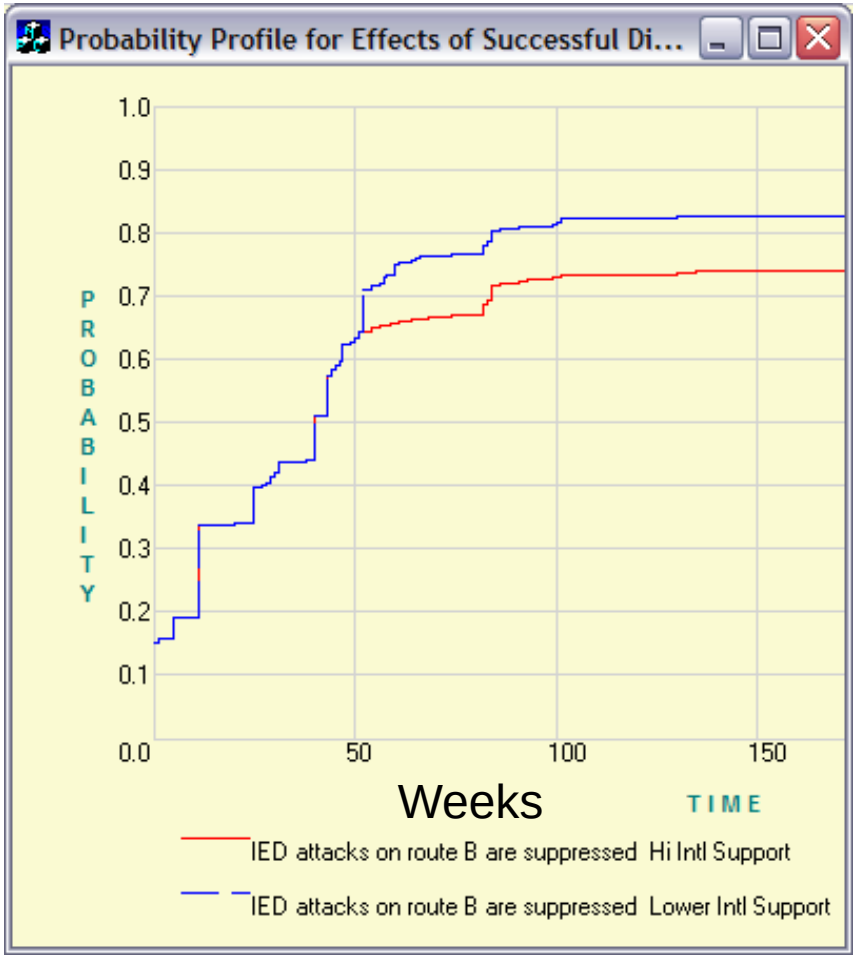
RESULTS (TEMPORAL)

- Assigning temporal information (time delays) to the links and nodes in the model, converts the influence net to a timed influence net.
- One can experiment with the set of actions and their timing and see the probability of different effects as a function of time.
- Changing actions or timing can effect the likelihood of various effects over time.
- The COA can be “tuned” to generate the best probability profile.
- The COA being tested shows that it will take 6 months to significantly reduce IEDs, they will be reduced more on the A route than the B
  - Note the cross over of local versus regional support for insurgency after about 21 months



RESULTS (TEMPORAL)

- COAs can be compared
- Example shows previous COA compared to one that using diplomatic efforts to reduce international support for insurgents by week 26 for the effect that IED attacks on Route B are suppressed
  - It shows some improvement but it takes about 6 months for the action to take effect
- Pythia offers a set of other algorithms and utilities to support the evaluation of the COA and the model.
  - Sensitivity Analysis
  - Set of Actions Finder
  - COA selection and "optimization"
  - Incorporation of evidence



CONCLUSION

- We have demonstrated the use of the Timed Influence Net technology and the Pythia tool for Course of Action Analysis
- Such models represent knowledge created by humans using data and information contained the various sources and data bases to generate knowledge about the situation
- A Layered approach is used
  - Layer one is the logical level showing key effects, beliefs, decision, and actions and the causal or influencing relationships between them. Can support explanations of the cause/effect rational for potential COAs
  - Layer two is the static quantitative level that incorporates "strengths" of causes or influences plus "baseline" probability estimate. Can support quantitative comparison of sets of actions that make up COAs
  - Layer three is the dynamic level that incorporates timing information. Support analysis of and selection of COAs