LOEs and the TRAC IW Metric Ontology

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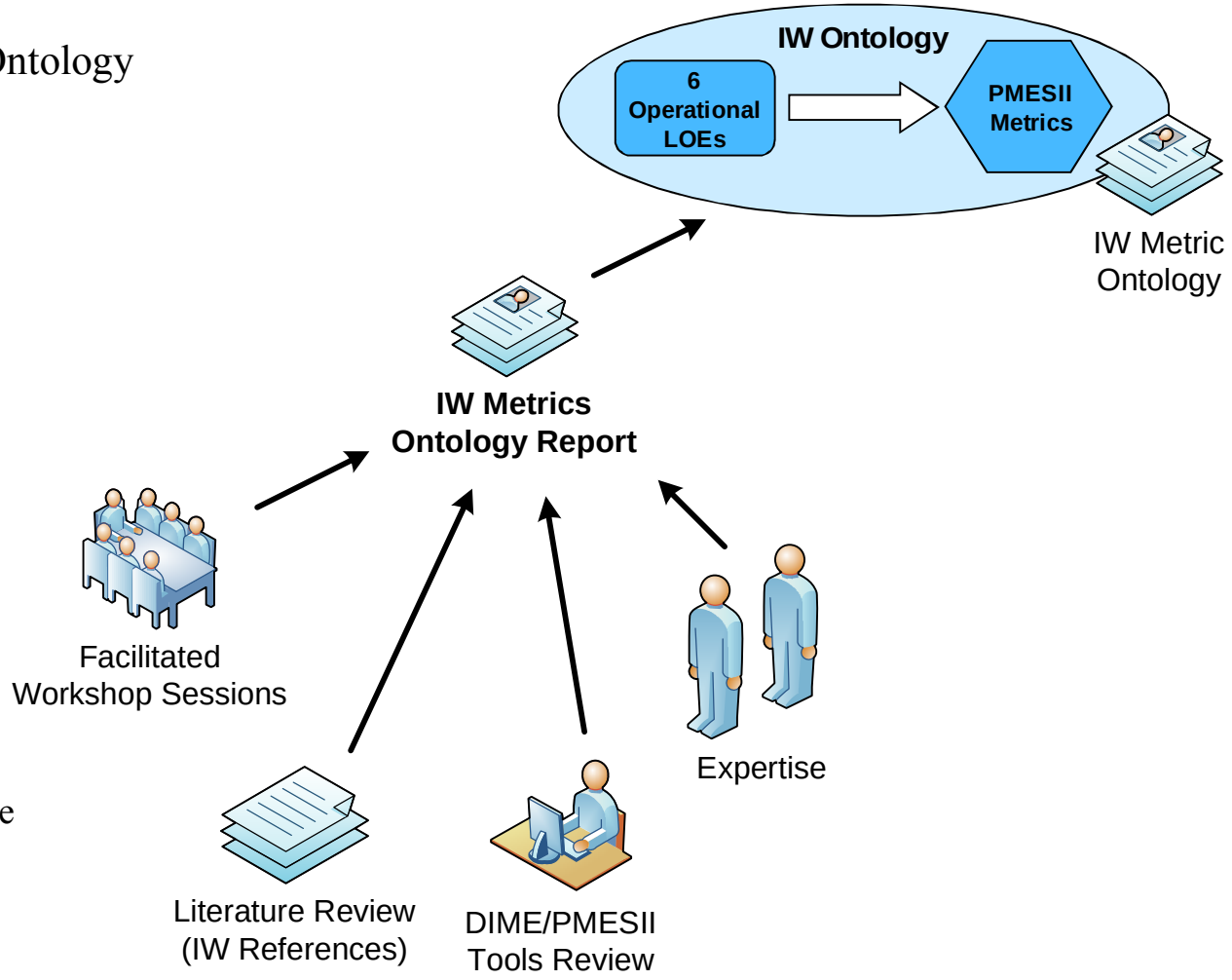
BLUF

- Irregular Warfare Ontology
  - Controlled vocabulary of state variables
  - Basic relationships within Operational Environment
  - Implemented in Web Ontology Language (OWL)
- State variables (metric types) describe status of
  - Actions
  - Actors
  - Environment (natural & human, physical & mental)
- Ontology
  - Begins with taxonomy: PMESII + kinetics + natural environment
  - Allows metric types to be in multiple categories
  - “Comprehensive” list of ~400 metric types
- Association of metric types with LOEs

Concepts

IW Metrics Ontology Development
Project Activities and Deliverables

- Producing IW Metrics Ontology
  - linking LOEs
  - to PMESII Metrics
- Created through
  - Workshops
  - Literature review
  - Tools review
  - Expertise
- Developing
  - IW definitions
  - Ontology definitions
  - LOE definitions
  - PMESII definitions
  - Metric definitions
  - Operational knowledge

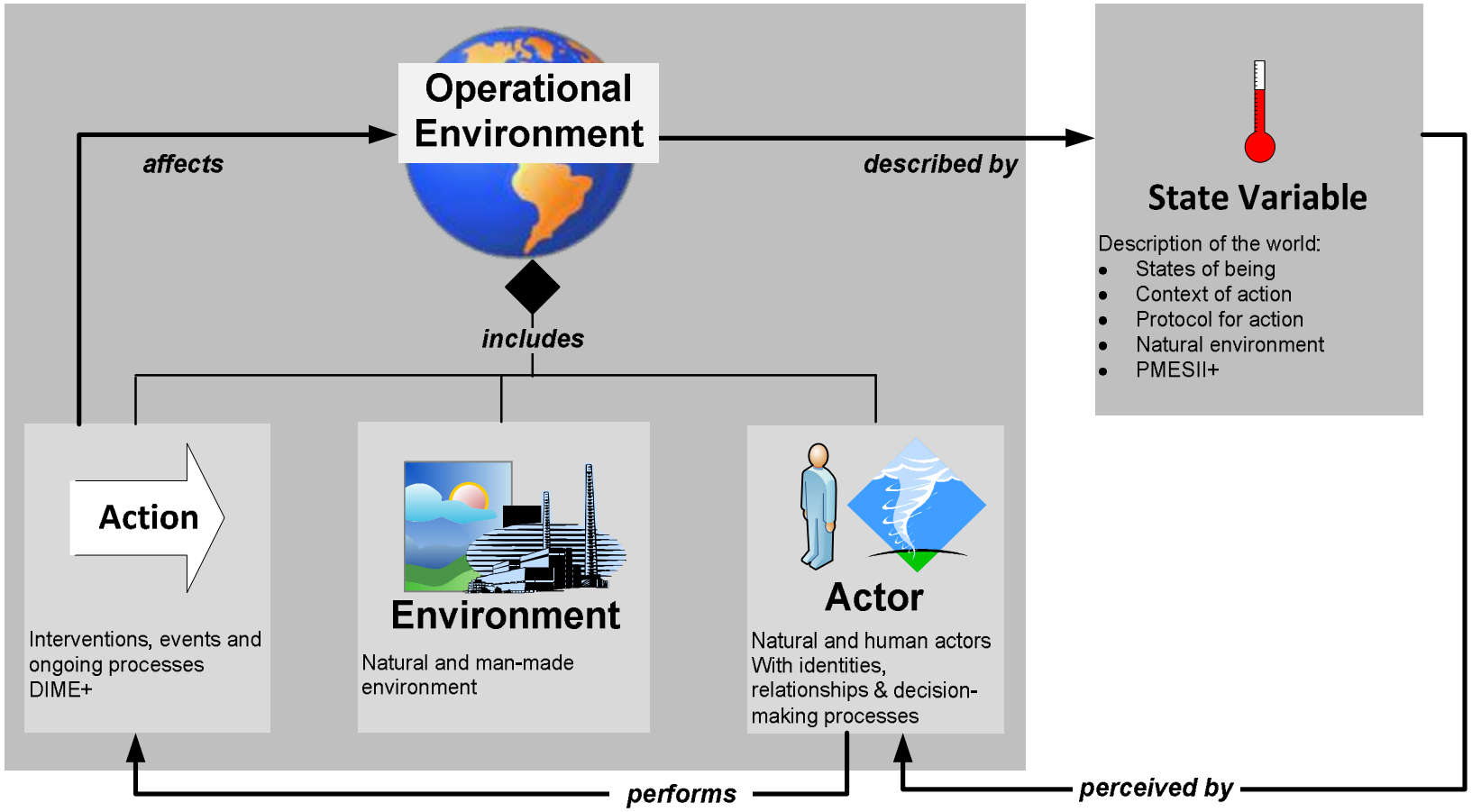


TRAC contracted with DRC and Hartley Consulting to develop an IW Metrics ontology

Literature

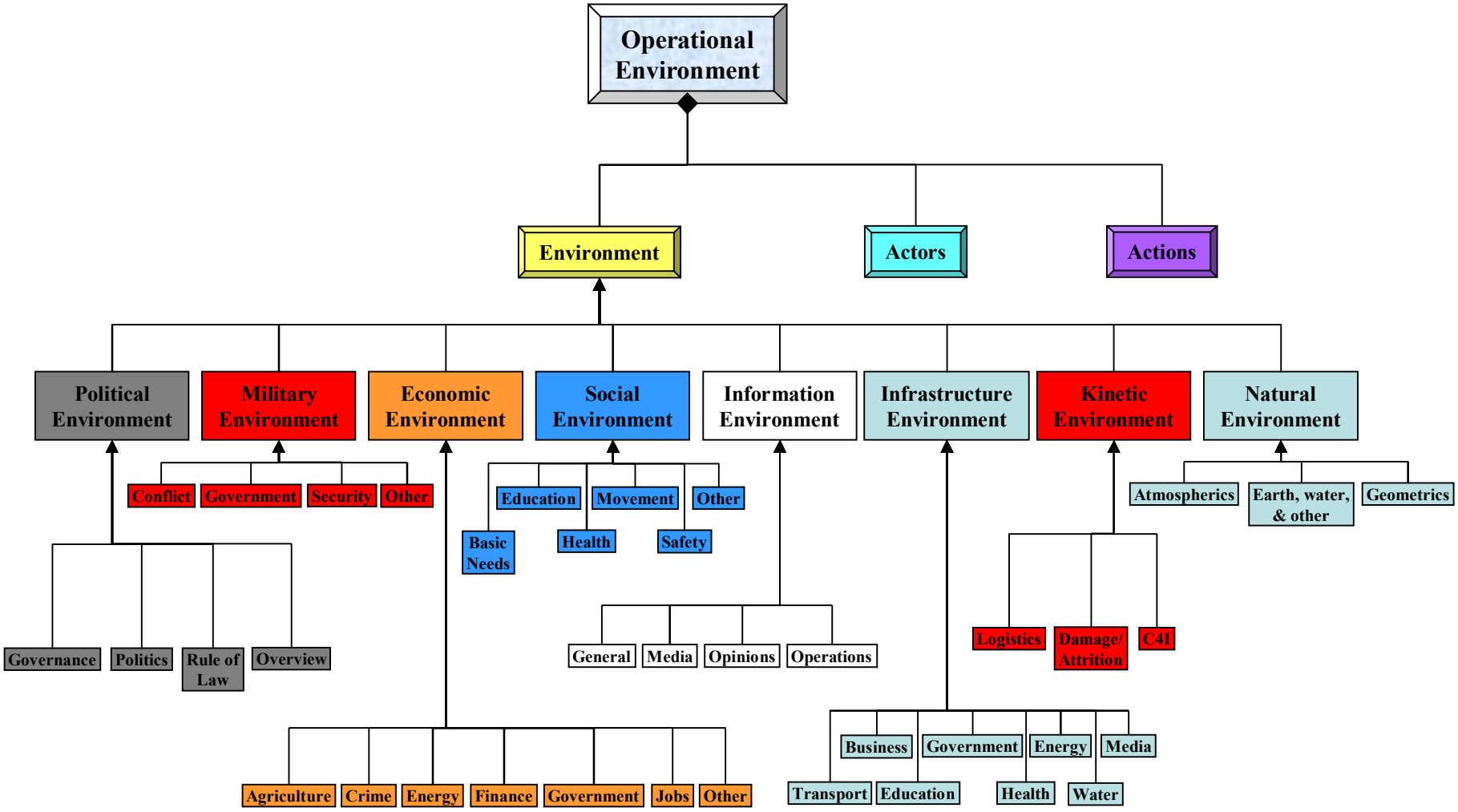
- General concepts and relationships
  - Doctrine (e.g., Joint Pubs, Army FMs)
  - Workshops (MORS, NDU, HSCB)
  - Books, articles and presentations
- Initial sources for metrics and taxonomy
  - Hayes & Sands *Doing Windows*: 119
  - Interim Semi-static Stability Model (ISSM): 195
  - DIME/PMESII VV&A Tool: 285
- Confirmatory and Additional metrics and taxonomies
  - HSCB Taxonomy: 345
  - Metrics v3: 226
  - OCRS Matrix: 217
  - NDU Corruption Workshop: 131
  - IW Decomp 2009: 99
  - MPICE: 62
  - PRIME Taxonomy: 59
  - Hilson: 54
  - Others
- Total metric types 415

Scope Domain - Context Diagram

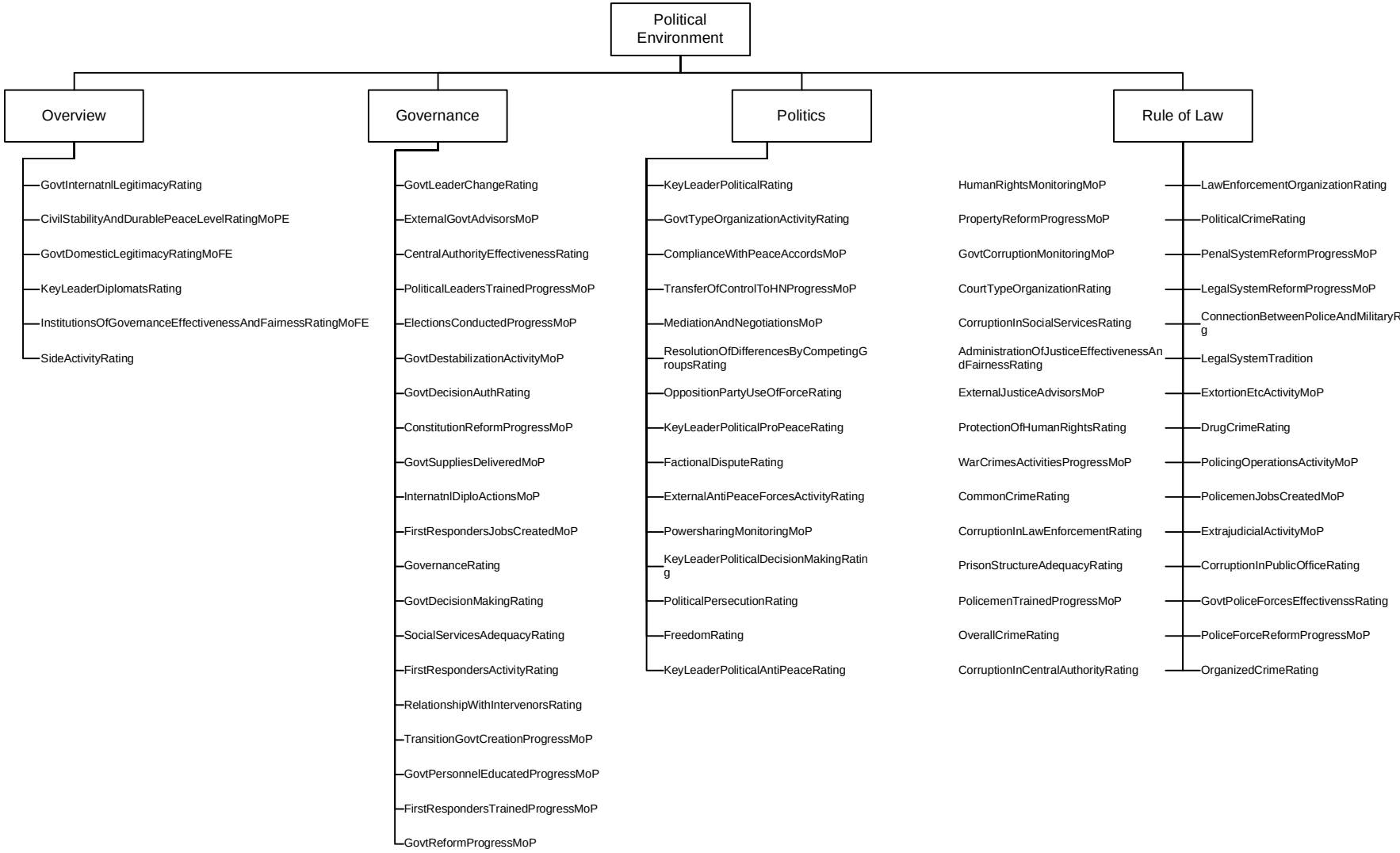


Metrics can be thought of as state variables that describe the Operational Environment.

Operational Environment Decomposition



Example Mapping of Political Environment to Associated Metric Types



Lines of Effort (LOEs)

LOEs, Sub-Tasks, and Endstates

- Taken from FM3-24.2, pg 4-8, 21 April 09
- Sub-Tasks are Actions at a larger scale than our DIME+

LOE	Subtasks						LOE Endstate
Establish Civil Security (Combat Operations)	Restore and Maintain Order	Conduct Operations to Halt Violence	Establish Border Security	Provide Public Safety Support	Provide Civil Defense Support	Perform HN Police training and Support	LOE Endstate 1: Safe, secure, and stable environment established.
Establish Civil Control (Police-Type Operations)	Provide Rule of Law Support	Conduct Populace and Resource Control	Disarm, Demobilize, and Reintegrate Ex-Combatants	Resettle Displaced Citizans	Provide Populace with Humane Care and treatment	Support HN Police, Fire, Rescue, and Penal Units	LOE Endstate 2: Rule of Law Established.
Support Host Nation Security Forces	Identify Indigineous Security Forces	Condcut Training of Security Forcres	Integrate HN Security Forces into COIN Operations	Trainsisiton to HN Control of Security Forces	Trainsition to HN Lead in COIN Operations	Transition to HN-only Security Forces	LOE Endstate 3: Self sufficient national security forces established.
Restore Essentioal Services	Restore Sewage Services	Restore Water Services	Restore Electrical Power and Services	Restore Academic Institutions	Restore Trash Services	Restore Medical Services	LOE Endstate 4: Essential services restored.
Support to Economic and Infrastructure Development	Provide Public Works Support	Provide Commernce Support	Provide Civilian Supply Support	Provide Civilian Healt Support	Provide Agriculture Support	Coordinate Civic Assistance Programs	LOE Endstate 5: Economic foundation w/sufficient infrastructure established.
Support to Governance	Provide Public Administration Support	Identify and Recruit Leaders	Facilitate Local Government	Provide Cultural Affairs Support	Support and Secure Elections	Support HN Reforms	LOE Endstate 6: Functioning legitimate gov't that does not require external support.
Conduct Information Tasks	Tell the Story to the U.S. Public	Marginalize Insurgent Influence	Isolate Population from Insurgent Forces	Provide Context for Host Nation Government Operations	Reinforce the Legitimacy of the Host Nation Government	Create Division Between Insurgent Leadership and Armed Insurgents	LOE Endstate 7: Increased support to HN (local) government.

LOEs Selected for the Ontology

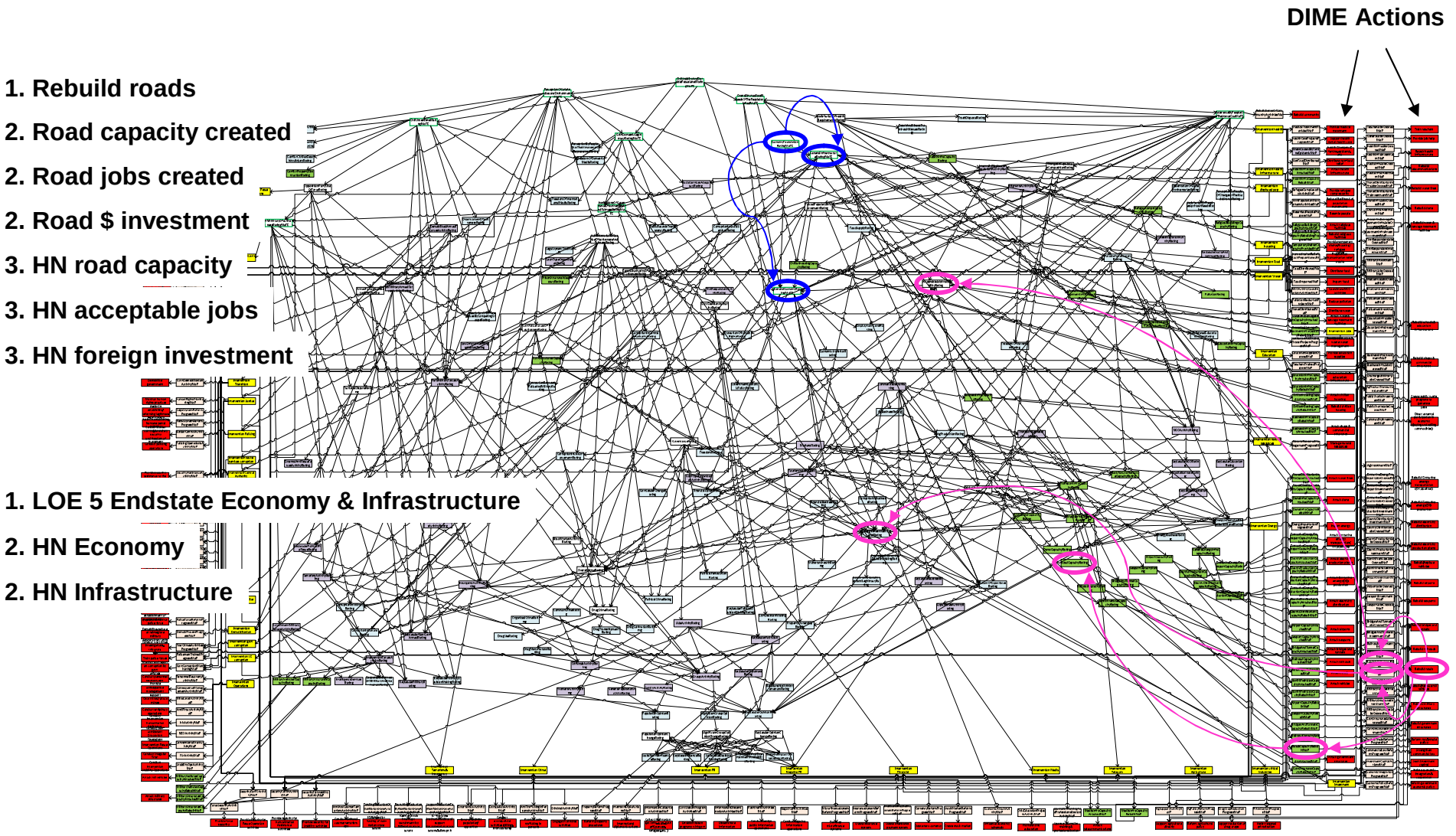
Rpt LOEs (DL6)

LOEid	Title
LOE01	Establish Civil Security
LOE02	Establish Civil Control
LOE03	Support Host Nation Security Forces
LOE04	Restore Essential Services
LOE05	Support to Economic and Infrastructure Development
LOE06	Support to Governance

LOEs → Metric Types

- Step 1: Identify DIME actions
  - FM 3-24.2 calls out subtasks for each LOE
  - Each subtask is clearly associated with one or more DIME actions
  - Several DIME actions are also implied (e.g., force security)
- Step 2: Identify DIME MoPs
  - Measures that are clearly associated with performing the given action, regardless of situation or modeling choices
  - Measures are inputs or direct outputs (e.g.,
    - $ invested
    - jobs created
    - number of diplomatic actions
    - road capacity built
- Step 3: Identify additional direct Metrics
  - Requires a model of what interacts with what
  - Include metric types that are directly affected by DIME MoPs
- Step 4: Work backward from LOE Endstates
  - Requires a model
  - Start with LOE Endstates and include metric types that directly effect them
  - Continue backward

Model of ~400 Metric Types + DIME Actions



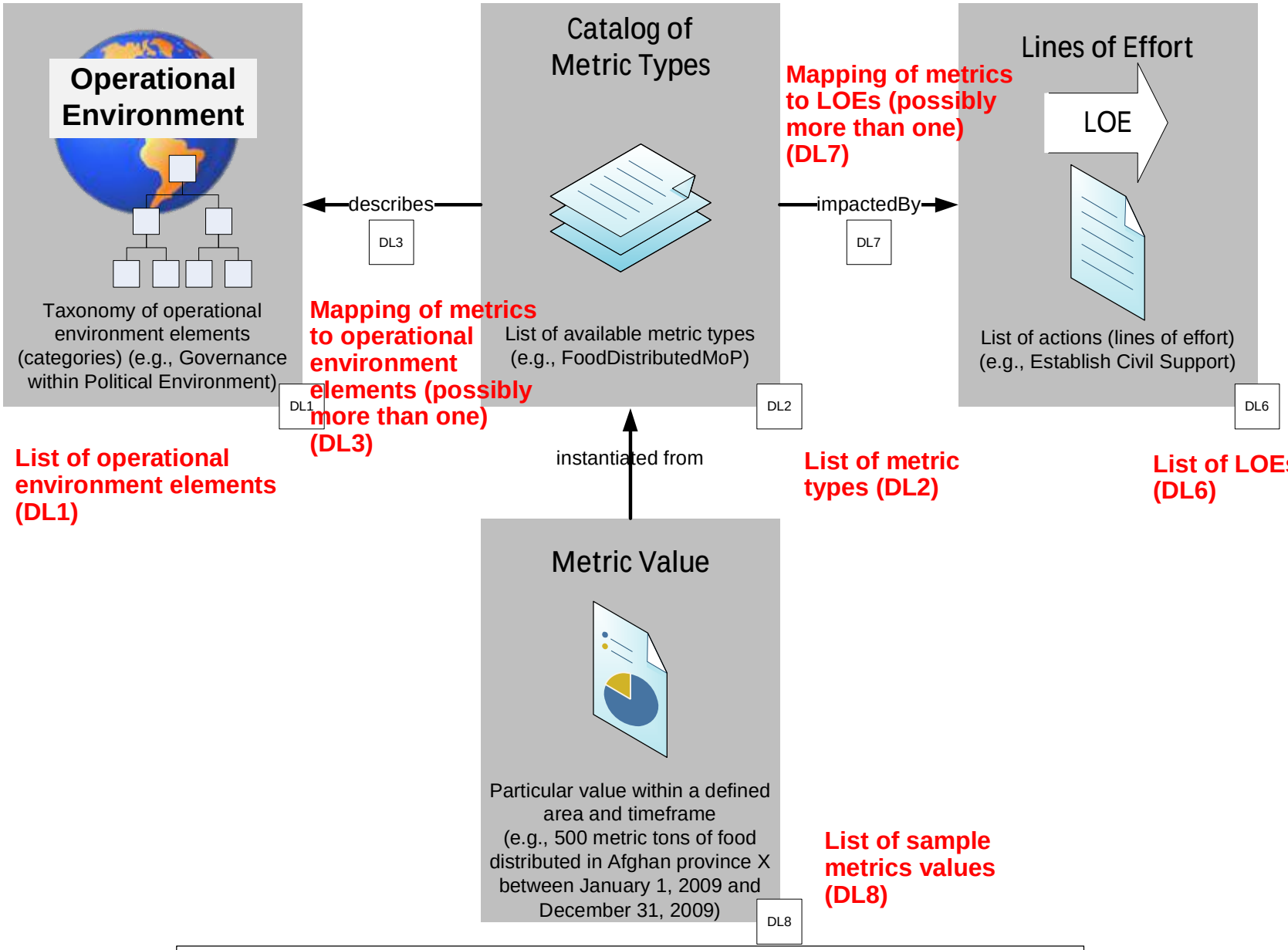
Metrics Mapped to LOEs

Rpt Metrics by LOEs (DL7)

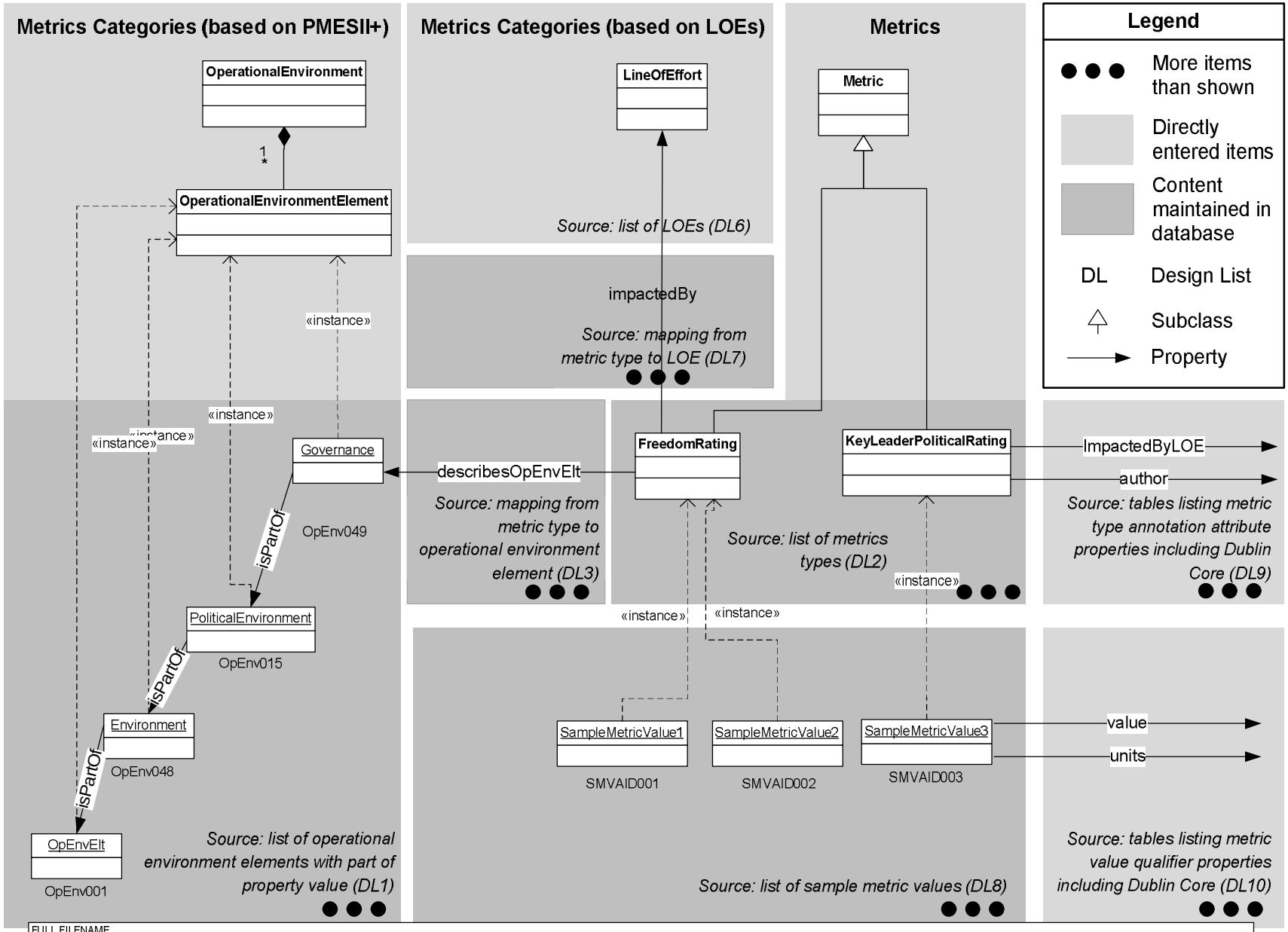
Title	MetricClassName
Establish Civil Control	
	AntiPopulationMovementActivitiesMoP
	AntiTraffickingInPersonsActivityMoP
	CivicEducationProjectsActivityMoP
	CommandAndControlEstablishedMoP
	CommunicationsEstablishedMoP
	ConfidenceBuildingActivityMoP
	DemobProcessProgressMoP
	DischargedMilitaryJobsCreatedMoP
	DischargedMilitaryTrainedProgressMoP
	ExternalGovtAdvisorsMoP
	ExternalJusticeAdvisorsMoP
	FirstRespondersTrainedProgressMoP

Ontology Implementation

High Level Ontology Context

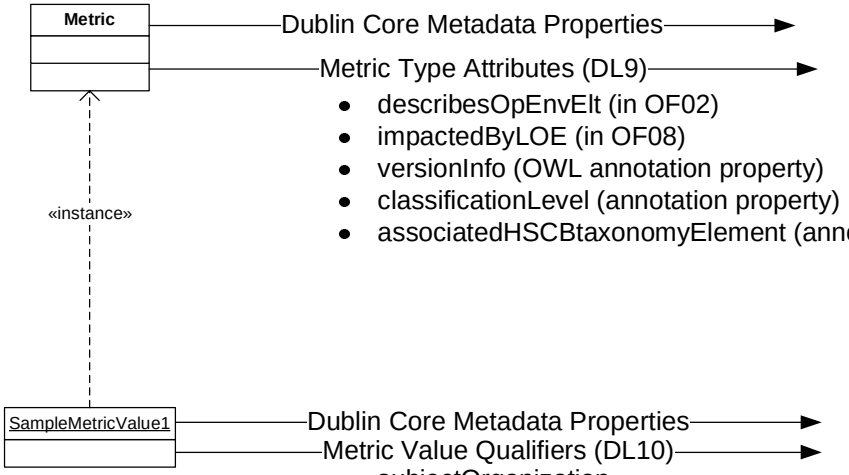


Ontology Class/Property Design



FULL FILENAME
C:\BACKUP_LL\PM\ORLANDO\PROJECTS\PMESII LOE METRIC ONTOLOGY\WORK\DOMAIN ONTOLOGY\IWMETRICS ONTOLOGY DESIGN 031011.VSD

Metric Properties in Ontology File OF01



- describesOpEnvElt (in OF02)
- impactedByLOE (in OF08)
- versionInfo (OWL annotation property)
- classificationLevel (annotation property)
- associatedHSCBtaxonomyElement (annotation property)

- subjectOrganization
- subjectLocation
- trustLevel
- relatedCOCOM
- unitOfMeasure
- metricValue
- relatedDoSRegionalBureau
- relatedDoSFunctionalBureau
- responsibleOrganization
- collectionSystemUsed
- sourceMetricValue
- valueRepresentation
- beginningDateTime
- endingDateTime
- valueDatatype
- derivedMetric
- dateCollected
- transformedMetric
- obtainedFrom
- dateObtained

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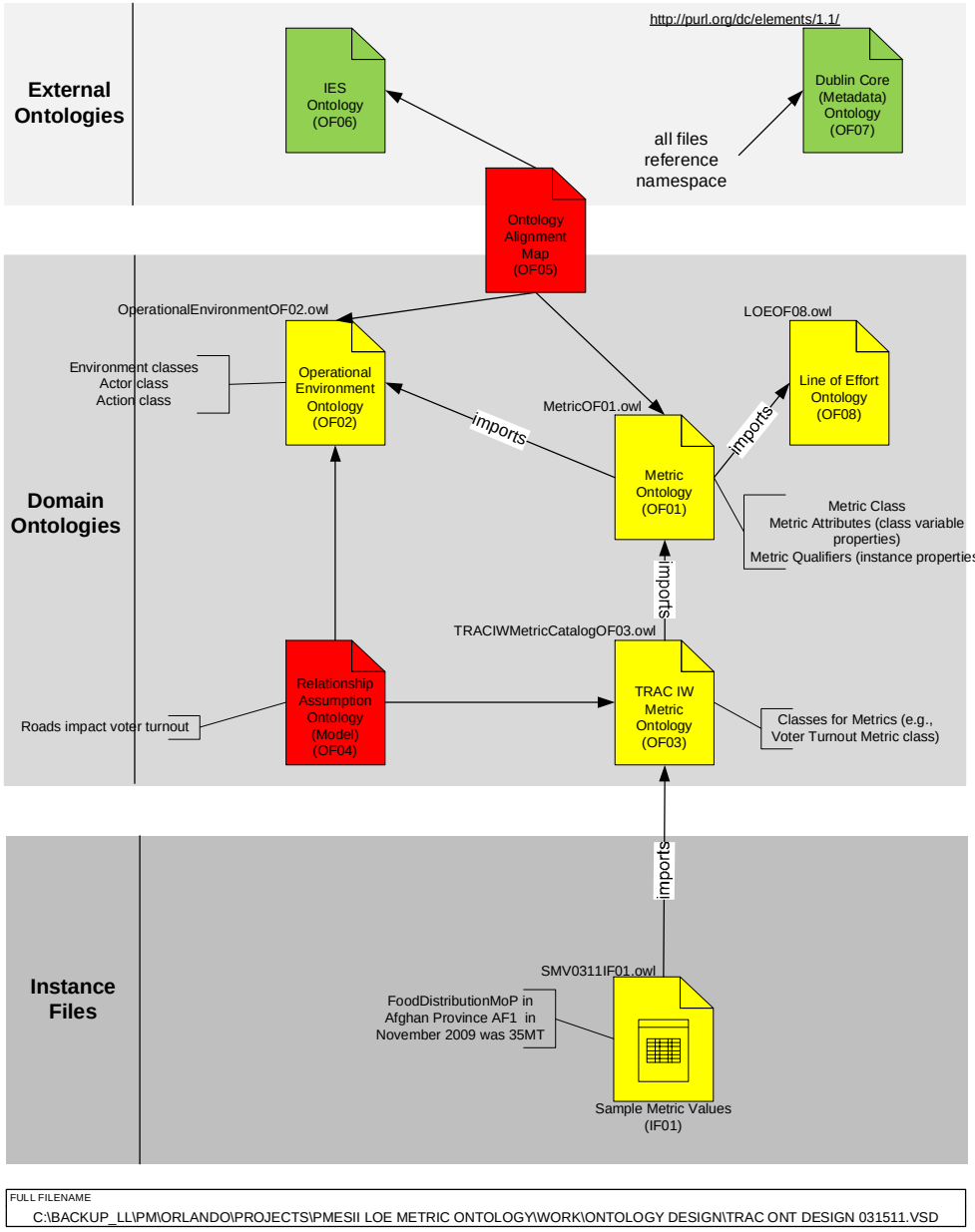
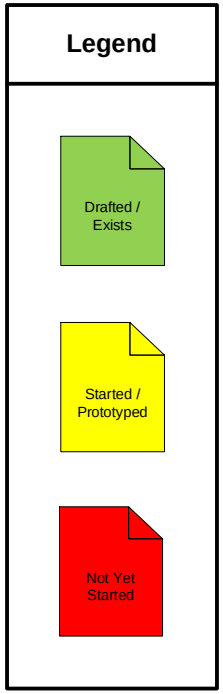
Ontology and Instance File Relationships





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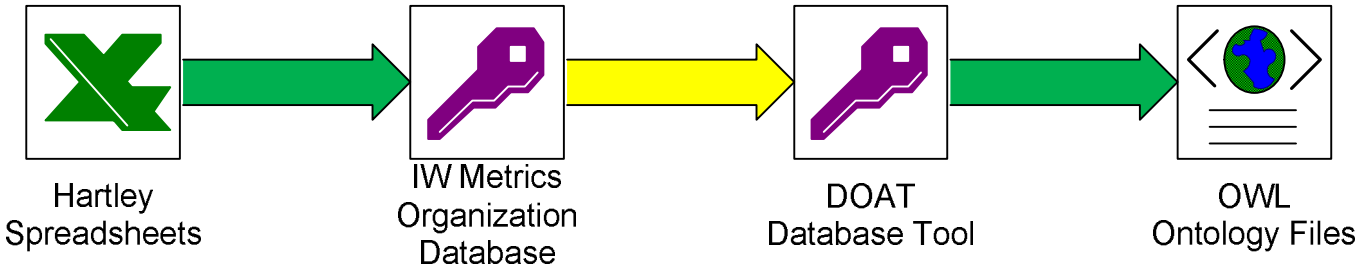
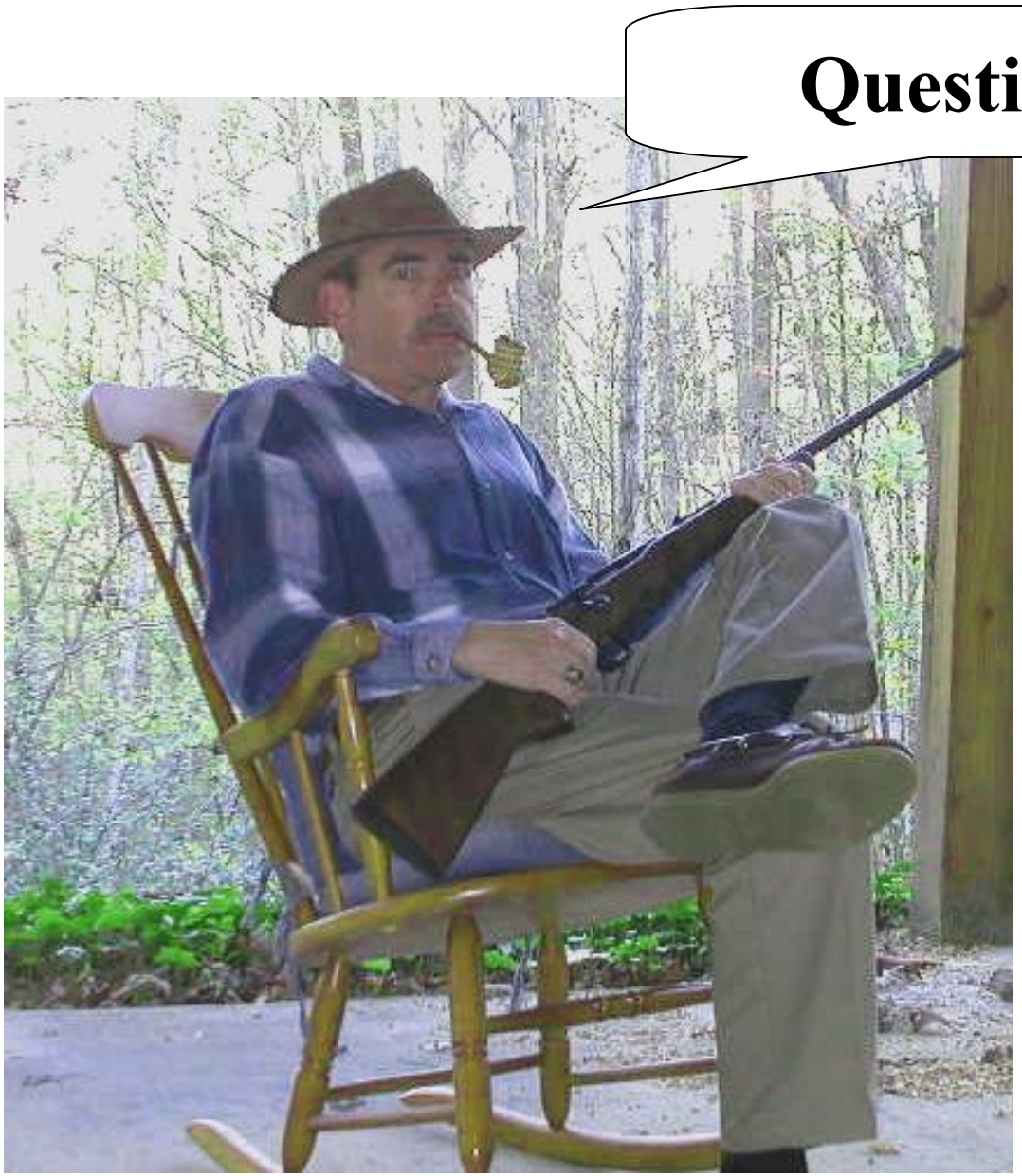
OWL Encoding Evolution



Using the Ontology

- Create Use Cases
  - Use lists
    - List of Metric Types valuable in identifying what should be modeled
    - List of LOE related Metric Types valuable in identifying what data are needed for making decisions
  - Query ontology for …
- Use Use Cases
  - Identify what can be done with current capabilities
  - Identify what new capabilities are needed
  - Group capabilities by Use Case
  - Estimate costs for creating capability groups
  - Rank potential follow-on projects

From the hills of East Tennessee



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BACKUP SLIDES

Citations

DoingWindows	**Bradd C. Hayes and Jeffrey I. Sands, *Doing Windows: Non-Traditional Military Responses to Complex Emergencies*. CCRP, Washington, DC. 1998.**
ISSM	**Dean S. Hartley III, *Operations Other Than War (OOTW) Flexible Asymmetric Simulation Technologies (FAST) Prototype Toolbox: ISSM v4.00 Analysts' Guide*. DRC, Orlando, FL. 2006.**
VV&A Tool	**Dean S. Hartley III, *DIME/PMESII VV&A Tool* (Software). Hartley Consulting, Oak Ridge, TN. 2009.**
OCRS Matrix	**Office of the Coordinator for Reconstruction and Stabilization, "Post-Conflict Reconstruction Essential Tasks." US Dept of State, Washington, DC. 2005. http://www.crs.state.gov/index.cfm?fuseaction=public.display&id=10234c2e-a5fc-4333-bd82-037d1d42b725**
MPICE	**Michael Dziedzic, Barbara Sotirin, and John Agoglia, *Measuring Progress in Conflict Environments (MPICE): A Metrics Framework for Assessing Conflict Transformation and Stabilization, Version 1.0*. US Institute for Peace, Washington, DC. 2008.**
Hilson	**Roger Hilson, et al., *Requirements for a Government Owned DIME/PMESII Model Suite*. Office of the Secretary of Defense Modeling & Simulation Steering Committee, Washington, DC. 2009.**
IWDecomp2009	**IW Decomposition Analytic Strategy, TRAC, Overview Briefing for IW WG, 6 January 2009**
Corruption	**Dean S. Hartley III, "Corruption in Afghanistan: Conceptual Model," 21 August 2010**
Metrics v3	**Metrics v3.xls from TRAC**
PRIME	**PRIME Taxonomy from SRI**
HSCB	**HSCB Taxonomy from Gary Klein, Mitre**

File Contents

Operational Environment Elements (DL1)

Rpt OpEnv (DL1)

PrintOrder	OpEnvAID	UniqueID	OpEnvName	ParentElement
10	OpEnv001	OE	Operational Environment	
20	OpEnv048	Env	Environment	OE
30	OpEnv015	Pol	Political Environment	Env
31	OpEnv049	Governance	Governance	Pol
32	OpEnv051	Politics	Politics	Pol
33	OpEnv052	Rule of Law	Rule of Law	Pol
34	OpEnv050	Overview	Overview	Pol
40	OpEnv013	Mil	Military Environment	Env
41	OpEnv039	Conflict	Conflict	Mil
42	OpEnv040	GovernmentMil	Government (Military)	Mil
43	OpEnv042	Security	Security	Mil
44	OpEnv041	MilitaryOther	Other (Military)	Mil
50	OpEnv009	Economy	Economic Environment	Env

Metrics Types (DL2)

Rpt Metrics (DL2)

HartleySSrow	MetAID	UniqueID
	Met194	CooperationBetweenHNMilitaryAndInterv
	Met396	DamsCapacityAttackedMoP
	Met398	DamsCapacityRebuiltMoP
	Met399	DamsInvestmentMoP
	Met050	DisarmamentActivityRating
	Met255	MigrationMitigationActivityMoP
	Met047	ConflictPropertyDestructionRate
	Met046	ConflictCombatantDeathAndInjuryRate
	Met045	ConflictCivilianDeathAndInjuryRate
	Met352	SatisfactionOfPeoplesSpiritualNeeds
	Met346	PerceptionByPeopleOfChangesInTheirSoci
	Met022	NegotiationWBueraucraciesActivitiesMoP
	Met400	DamsJobsCreatedMoP
4	Met160	GovtDecisionAuthRating

Mapping Operational Environment to Metrics (DL3)

RptMetricsByOpEnvElt (DL3)

Operational Environment Component	Metric Name
Operational Environment	
Environment	
Political Environment	
Governance	
	GovernanceRating
	PoliticalLeadersTrainedProgressMoP
	InternatnlDiploActionsMoP
	GovtSuppliesDeliveredMoP
	GovtReformProgressMoP
	GovtPersonnelEducatedProgressMoP
	TransitionGovtCreationProgressMoP
	ConstitutionReformProgressMoP
	GovtDecisionAuthRating
	GovtLeaderChangeRating
	FirstRespondersTrainedProgressMoP
	FirstRespondersJobsCreatedMoP
	FirstRespondersActivityRating
	ElectionsConductedProgressMoP
	GovtDestabilizationActivityMoP
	CentralAuthorityEffectivenessRating

Sample Metric Values (DL8)

Rpt SampleMetricValues (DL8)

SMVAID	MetricType	MetricValue	Units	ıingDateTime	ıdingDateTime	Notes
1	FreedomRating	High	Scale	1/1/2010	12/31/2010	Florida
2	FreedomRating	Low	Scale	1/1/2010	12/31/2010	Libya
3	KeyLeaderPoliticalRating	Low	Scale	1/1/2010	12/31/2010	Libya

Metric Type (Attribute) Properties (DL9)

Property Name in Ontology	Description
describesOpEnvElt	identifies the PMESII category by indicating the element of the Operational Environment being described
impactedByLOE	identifies an LOE whose execution impacts the values of metrics of this type
versionInfo (OWL annotation property)	configuration management information (initially just a version number in a string)
classificationLevel	initially a string indicating level (e.g., “Unclassified”) (eventually BAH’s ISM3 ontology properties)
associatedHSCBtaxonomyElement	descriptor identifying associated HSCB taxonomy

Metric Value (Qualifier) Properties (DL10)

Property Name in Ontology	Description
subjectOrganization	organization being described by the metric value
subjectLocation	location being described by the metric value
trustLevel	trust level with 10 being absolute trust and 0 being no trust
relatedCOCOM	COCOM related to metric value
unitOfMeasure	initially a string identifying the units of measure for the metric value
metricValue	the metric value itself
relatedDoSRegionalBureau	name of related Department of State regional bureau
relatedDoSFunctionalBureau	name of related Department of State functional bureau
responsibleOrganization	organization responsible for geographic area
collectionSystemUsed	identification of system used to obtain data
sourceMetricValue	reference to another metric value used to derive the metric's value
valueRepresentation	explanation of value meanings (e.g., data type or Likert scale from 1-5 with
beginningDateTime	Beginning of time period being described
endingDateTime	End of time period being described
valueDatatype	Indication of datatype used to describe metric value
derivedMetric	yes indicates the value was derived from other values
dateCollected	date that metric value was collected
transformedMetric	yes indicates that the metric value was a transformation of another metric value
obtainedFrom	initially a string indicating source of information (e.g., "Wikipedia")
dateObtained	date on which metric value was obtained

Dublin Core Properties

Property Name in Ontology	Description
contributor	An entity responsible for making contributions to the resource.
coverage	The spatial or temporal topic of the resource, the spatial applicability of the resource, or the jurisdiction under which the resource is relevant.
creator	An entity primarily responsible for making the resource.
date	A point or period of time associated with an event in the lifecycle of the resource.
description	An account of the resource.
format	The file format, physical medium, or dimensions of the resource.
identifier	An unambiguous reference to the resource within a given context.
language	A language of the resource.
publisher	An entity responsible for making the resource available.
relation	A related resource.
rights	Information about rights held in and over the resource.
source	A related resource from which the described resource is derived.
subject	The topic of the resource.
title	A name given to the resource.
type	The nature or genre of the resource.

HSCB Taxonomy Items (DL4)

Rpt HSCBTaxonomy (DL4)

Descriptor	HSCBid	NativeHSCBid	Taxon	Reference
A-D	HSCBTax001	1	Diplomatic Actions	
A-D-01	HSCBTax002	1.1	Participate in Negotiations	[9] [5:1] [26]
A-D-02	HSCBTax003	1.2	Diplomatic or Quasi-Diplo	[9:2] [5:3] [26]
A-D-03	HSCBTax004	1.3	Establish Relations in Abse	[9:4]
A-D-04	HSCBTax005	1.4	Grant Diplomatic Recogniti	[9:5] [21]
A-D-05	HSCBTax006	1.5	Formal Agreement	[21]
A-D-05.01	HSCBTax007	1.5.1	Signing of Treaty or Coope	
A-D-05.02	HSCBTax008	1.5.2	Joining of Multinational In	
A-D-05.03	HSCBTax009	1.5.3	Agree to Ceasefire	
A-D-06	HSCBTax010	1.6	Diplomatic Goal-Directed	
A-D-06.01	HSCBTax011	1.6.1	Requests	[5:6]

Metrics to HSCB Taxonomy Mapping (DL5)

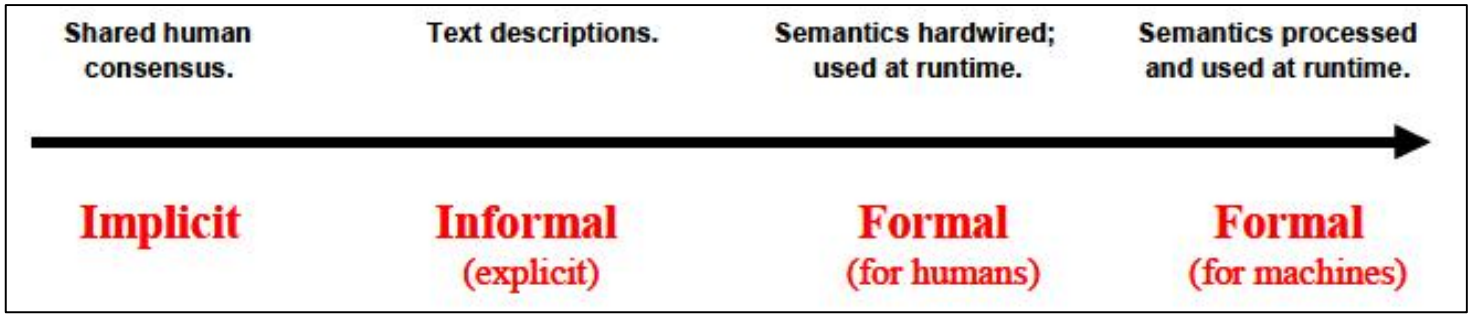
Rpt XREF Metrics HSCB Taxonomy SS order (DL5)

4	**GovtDecisionAuthRating**		
		E-P-02	Political Participation, Such as Voter Turnout
5	**GovernanceRating**		
		E-P-09	Governance Capacity (Governing Authority o
6	**FirstRespondersActivityRating**		
		O-A-02.02	Local civil authorities (elected and traditional
7	**GovtLeaderChangeRating**		
		E-P-08	Regime/Head of Government Change
9	**SocialServicesAdequacyRating**		
		O-A-02.02	Local civil authorities (elected and traditional
10	**GovtDecisionMakingRating**		
		E-P-03	Competitive Multiparty Electoral System (Pre
		E-P-06	Separation of Powers (Presence/Absence/De
		E-P-10	Legislative Activity

What is Ontology?

Ontologies Provide Benefits

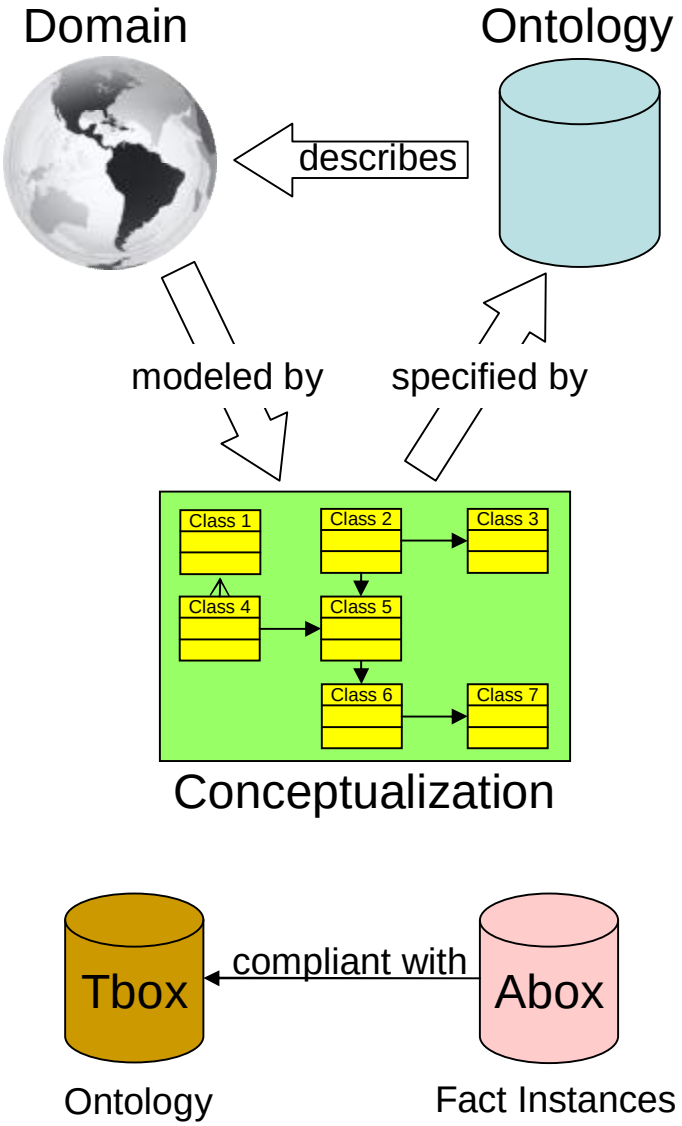
- Textual descriptions are ambiguous
- More formal representations enable more automated solutions
- Ontologies form a type of "compromise" between human readable text and computer processable data
- Relationships and restrictions between classes help support inferencing and "discovery" of additional facts



From: (Uschold, 2003)

What is an Ontology?

- Gruber Definition
  - An ontology is a "formal specification of a conceptualization"
  - That is, a formally described, machine readable collection of terms and their relationships expressed with a language in a document file
- Computer science literature differentiates
  - Terminological components (Tbox)
  - Assertional components (Abox)



Semantic Spectrum

Pump : "a device for moving a gas or liquid from one place or container to another"

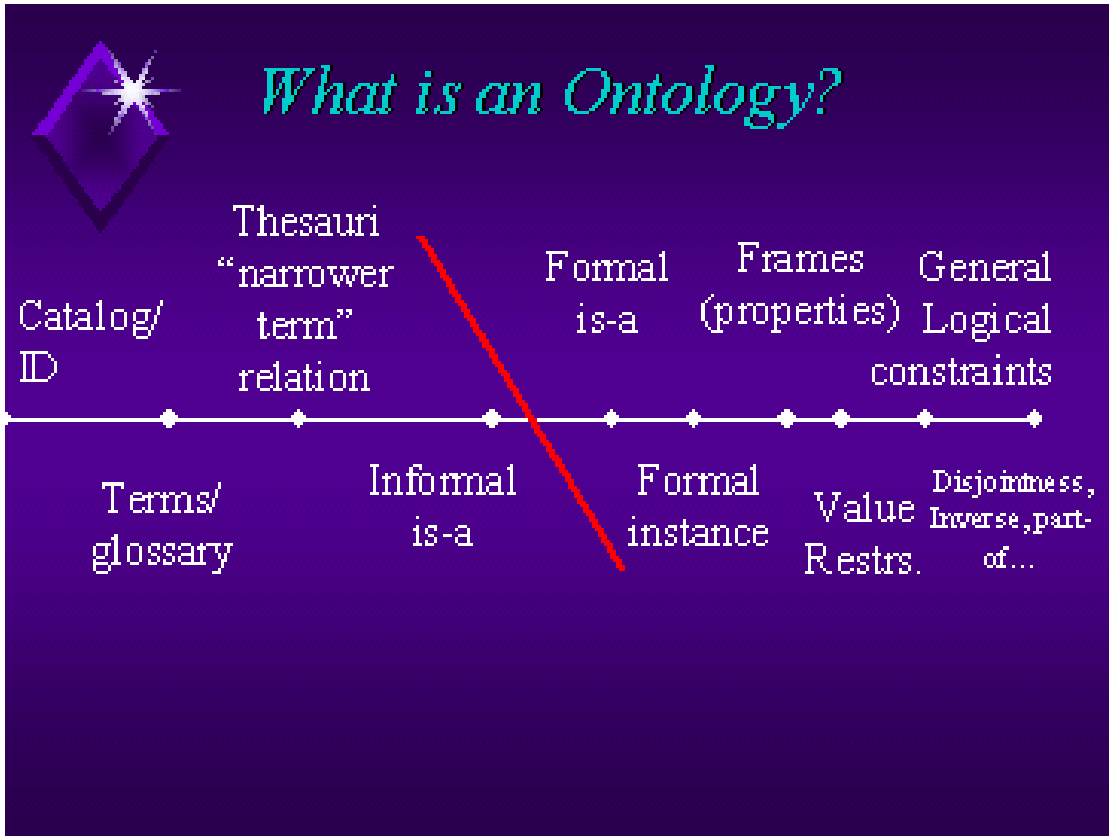
```
(pump has
      (superclasses (…))
```

Shared human consensus.	Text descriptions.	Semantics hardwired; used at runtime.	Semantics processed and used at runtime.

Implicit — **Informal** (explicit) — **Formal** (for humans) — **Formal** (for machines)

From: (Uschold, 2003)

Knowledge Representation Spectrum



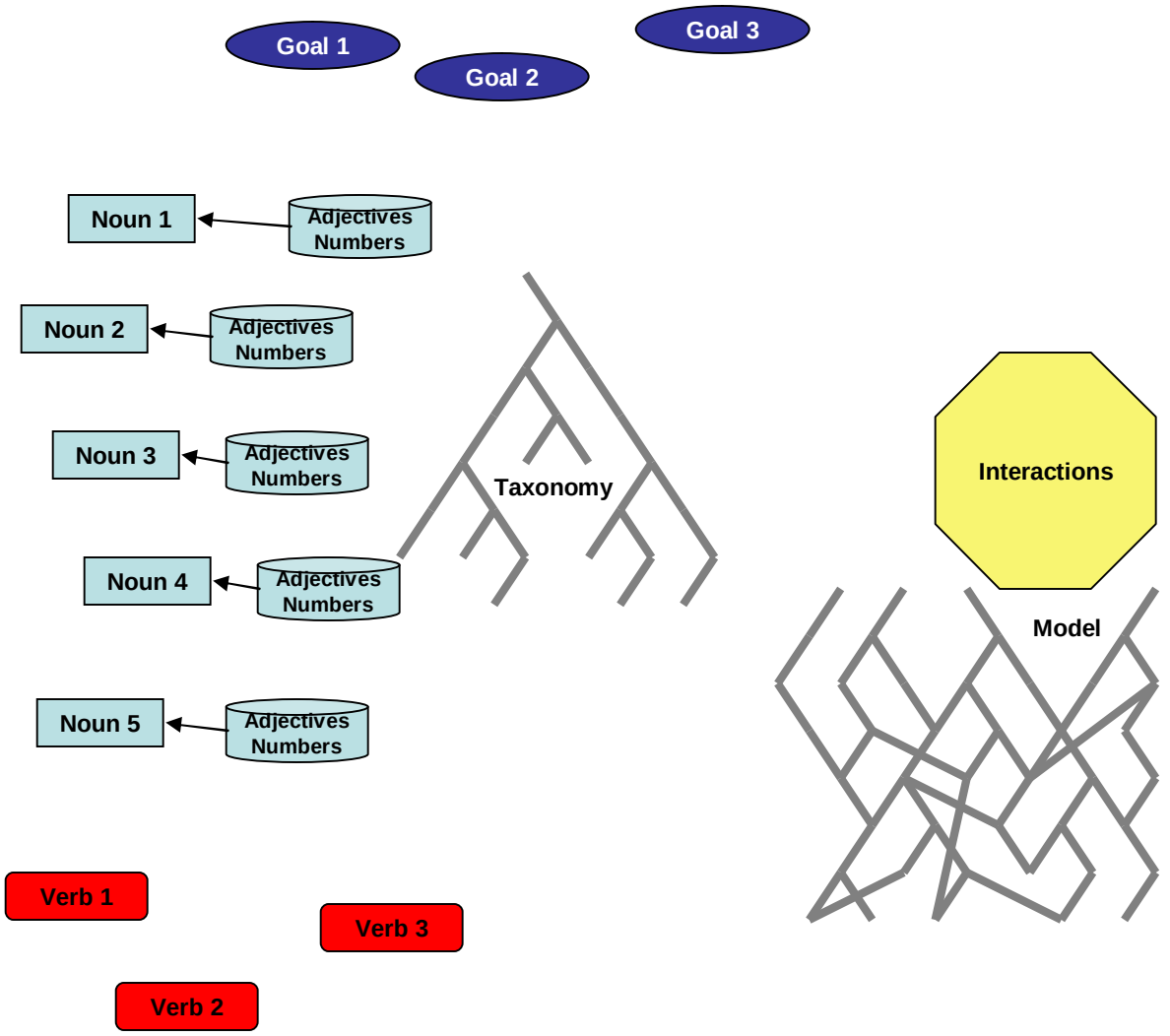
From: Deborah L. McGuinness. "Ontologies Come of Age". In Dieter Fensel, Jim Hendler, Henry Lieberman, and Wolfgang Wahlster, editors. Spinning the Semantic Web: Bringing the World Wide Web to Its Full Potential. MIT Press, 2003.

Naming the Problem

- End-state goals
- Status vector
- Actions to change status
- Interactions of above

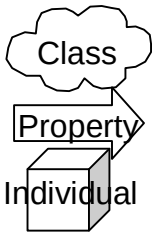
- Describe with taxonomy
- Add properties

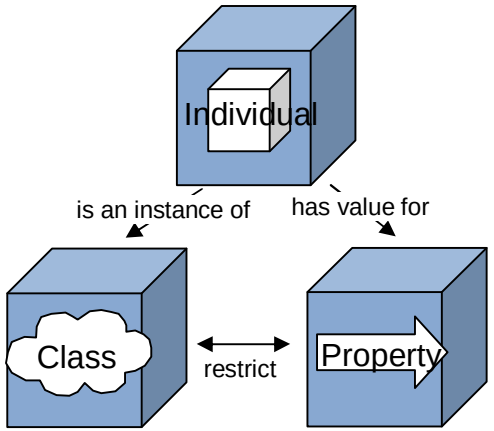
- Interactions are a model

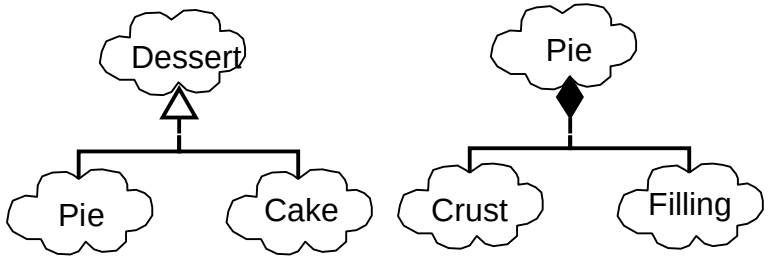


Ontology Concepts

- Information representation
  - Class
  - Property
  - Individual
- Relations between representations
  - Is an instance of (membership)
  - Has value for
  - Restrict (helps define class)
- Relations within representations
  - Synonymy (similar or identical) =
  - Antonymy (contrast or dichotomy) ≠
  - Hyponymy (is-a) △
  - Meronymy (part-of)/ Holonymy (contains) ◆

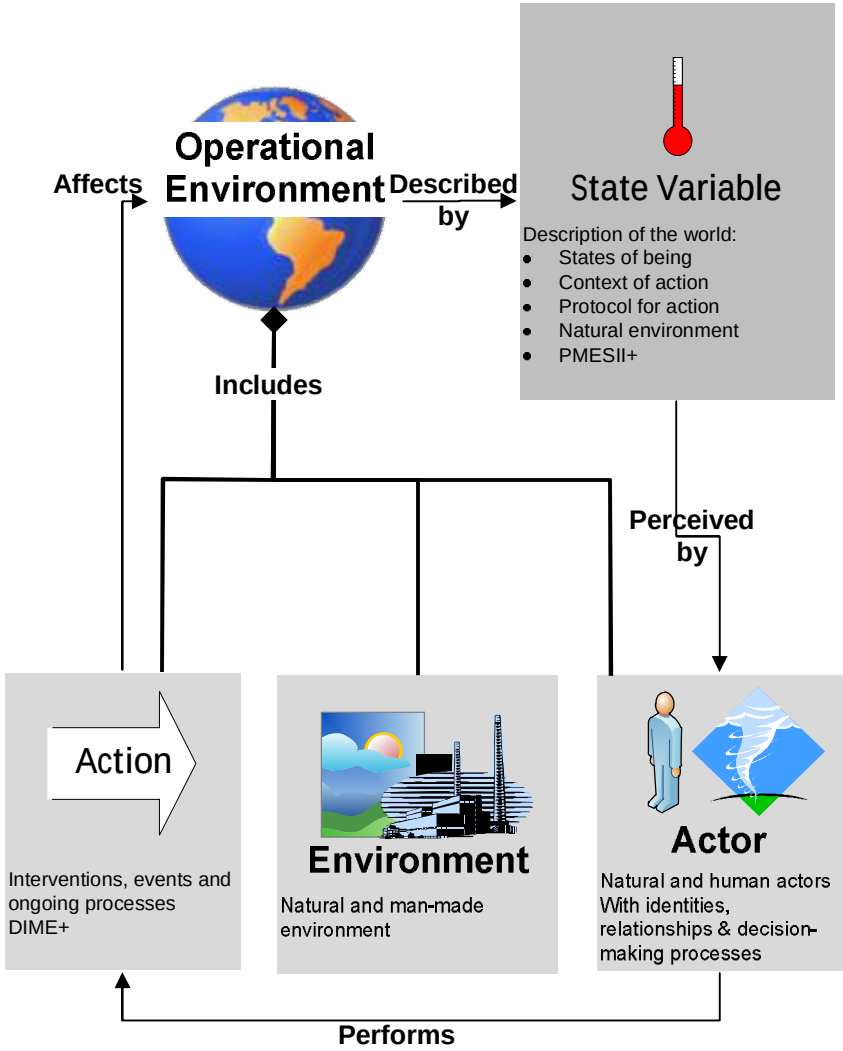






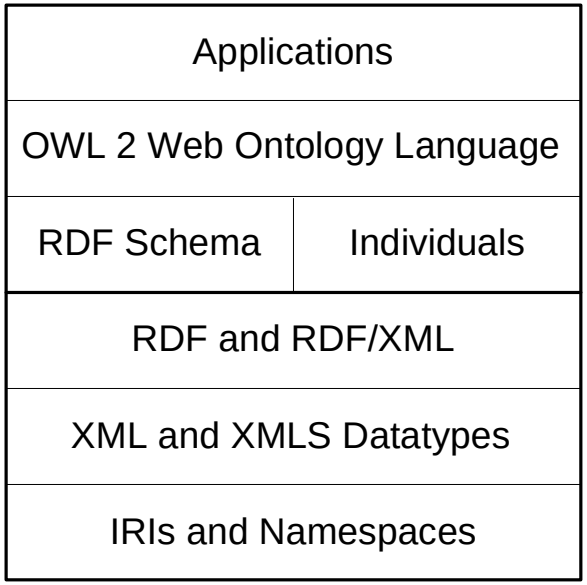
Ontology Elements

- State variables describe the Operational Environment
  - Actors
  - Actions
  - Environment
- Some terms are overloaded
  - "Train teachers"
    - Action
    - State variable giving the current status of the action
  - "Migrants"
    - State variable describing the extent of existence of migrants
    - Actor (if so modeled)
  - "Epidemic"
    - State variable describing the extent of the epidemic
    - Action
    - Actor (if so modeled)
  - "Flood/Tsunami"
    - Environmental element
    - Action (if so modeled)
    - State variable describing the status of the action
    - Actor (if so modeled)



Ontology Languages

- Concepts derived from Description Logics
- Represents an evolution (not revolution) in representing information
- Web Ontology Language – OWL standardized by W3C



Derived from:
(Lacy, 2005)

Ontology Layers

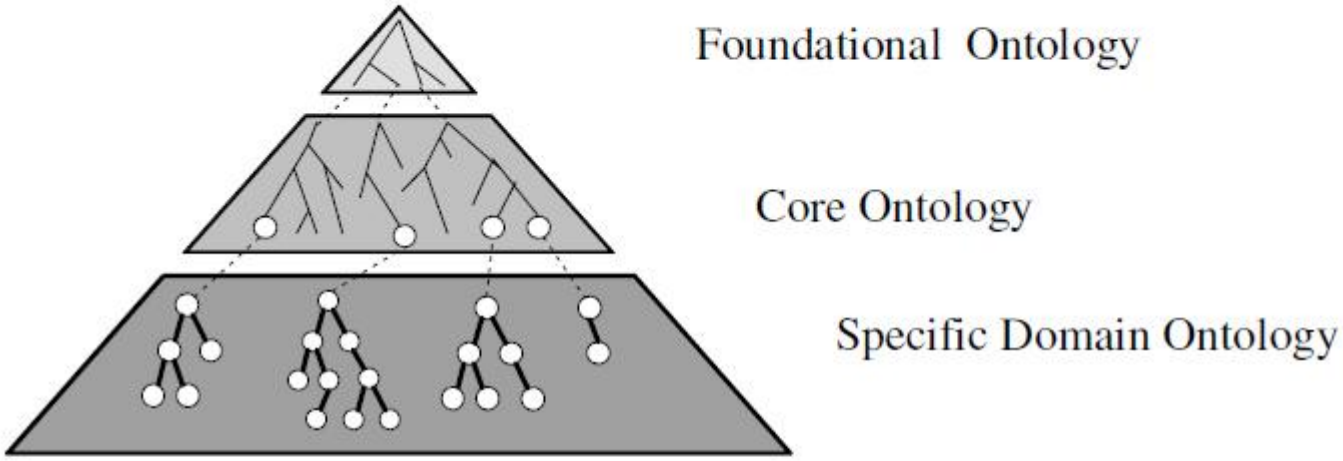


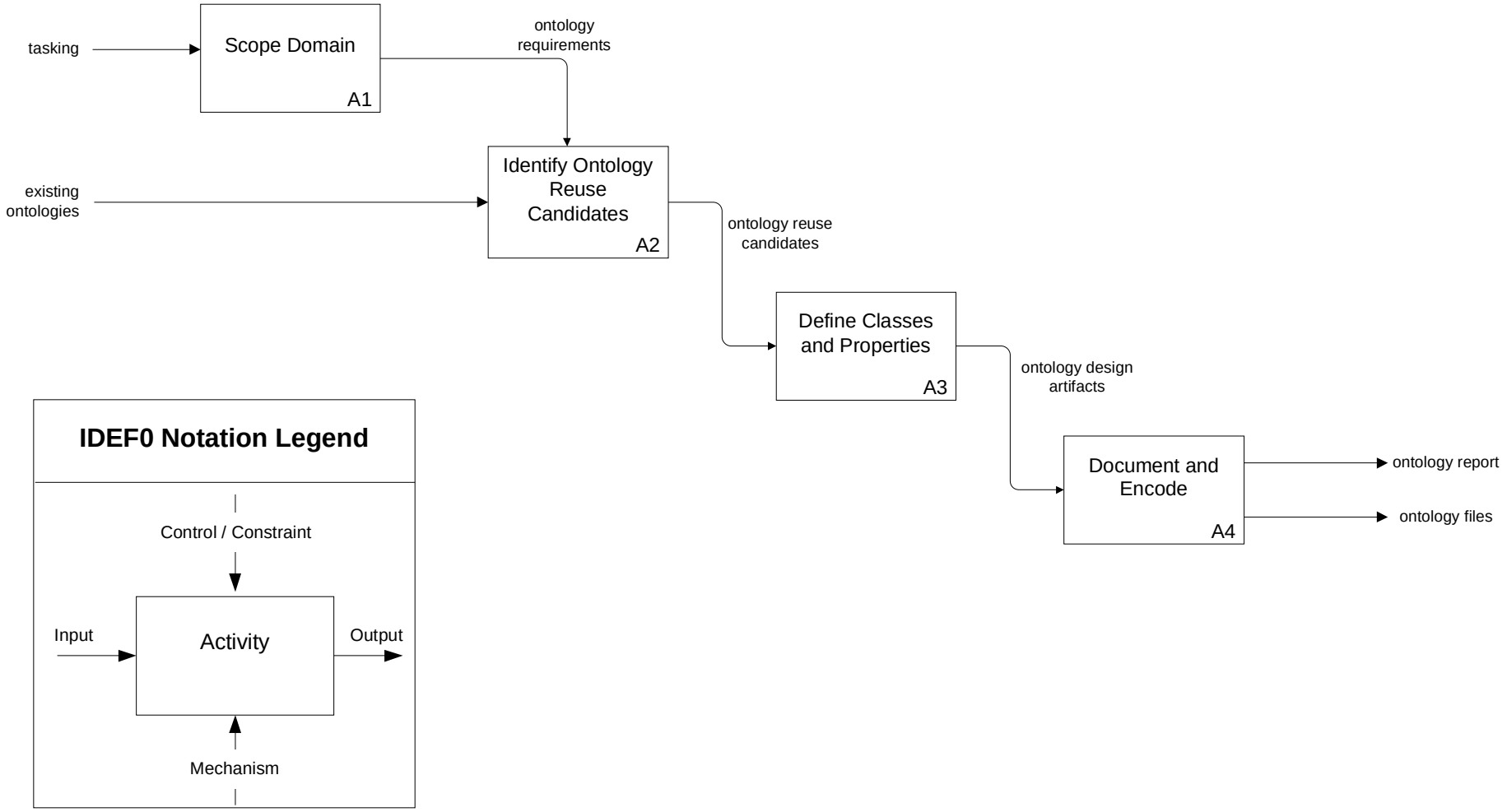
Figure 1
The three levels of generality of a domain ontology.

The issue of identifying these very few "basic" principles, now often referred to as **foundational ontologies** (FOs) (or top, or upper ontologies; see Figure 1) (Gangemi et al. 2002), meets the practical need of a model that has as much generality as possible, to ensure reusability across different domains (Smith and Welty 2001).

From: (Navi, 2004)

Ontology Development Process

Ontology Development Process

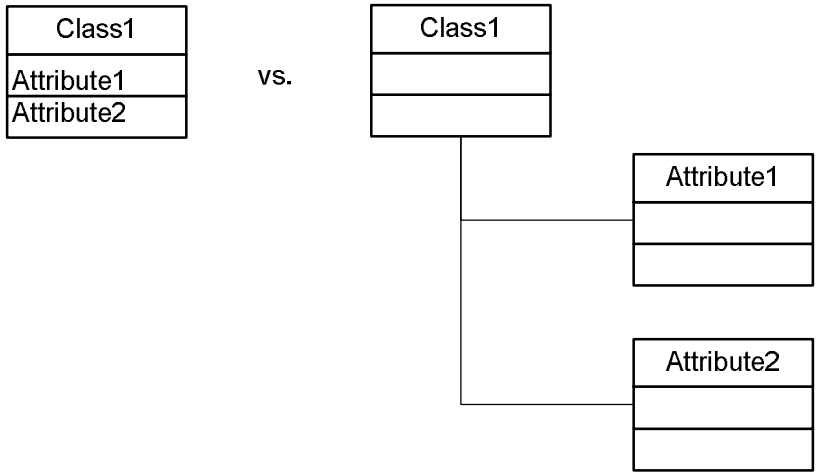


Describing the Elements

Describing a Metric

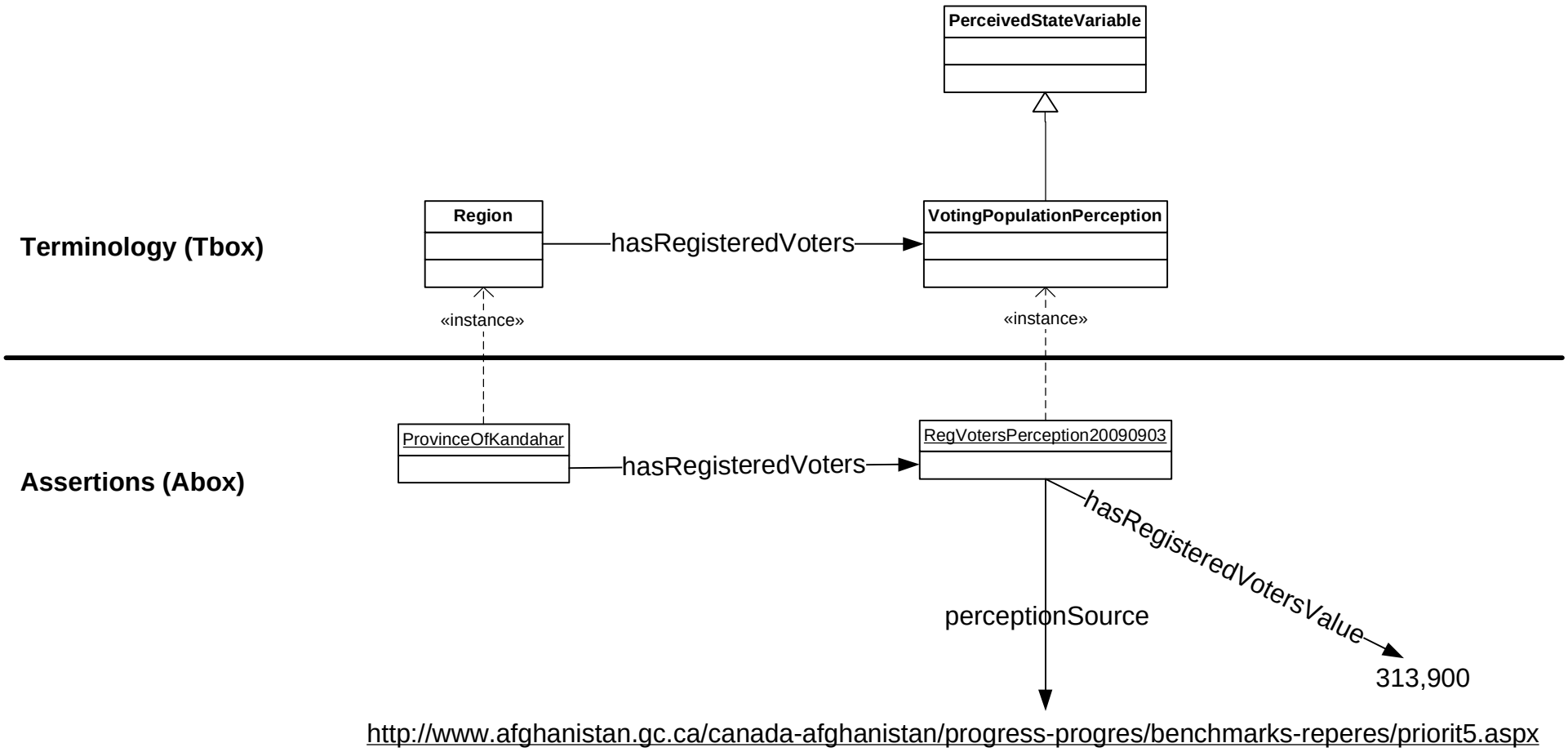
Attributes of a Metric:

- Name
- Definition
- Units
- Geographic association
- Author
- References
- Time-based



- Metrics become “first class” reusable well-defined objects in their own right that belong to classes and not just attributes of a objects being described (less tightly coupled)
- Assertions can be made to describe the attributes of a particular metric value

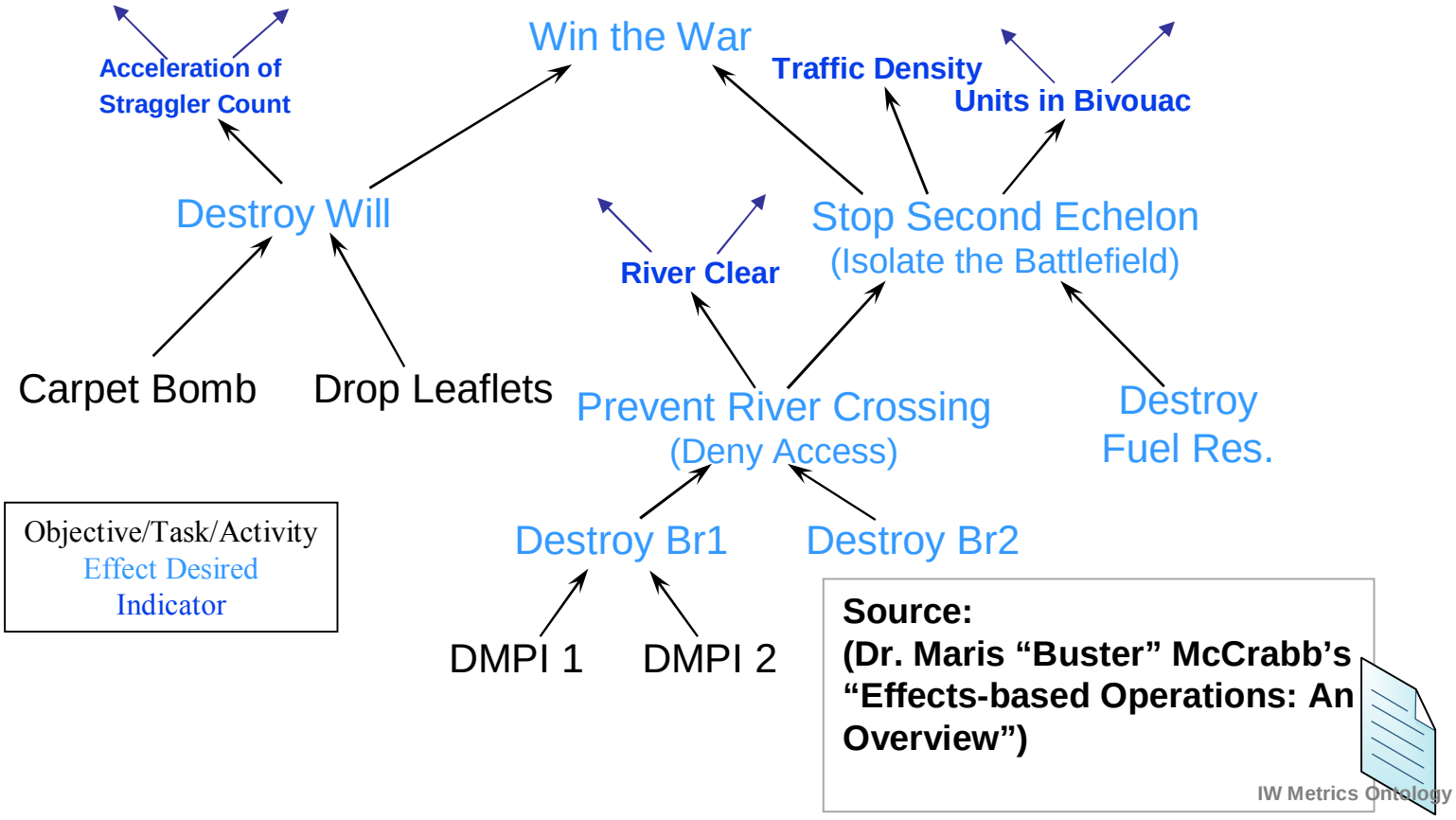
Representing Perceived Metrics



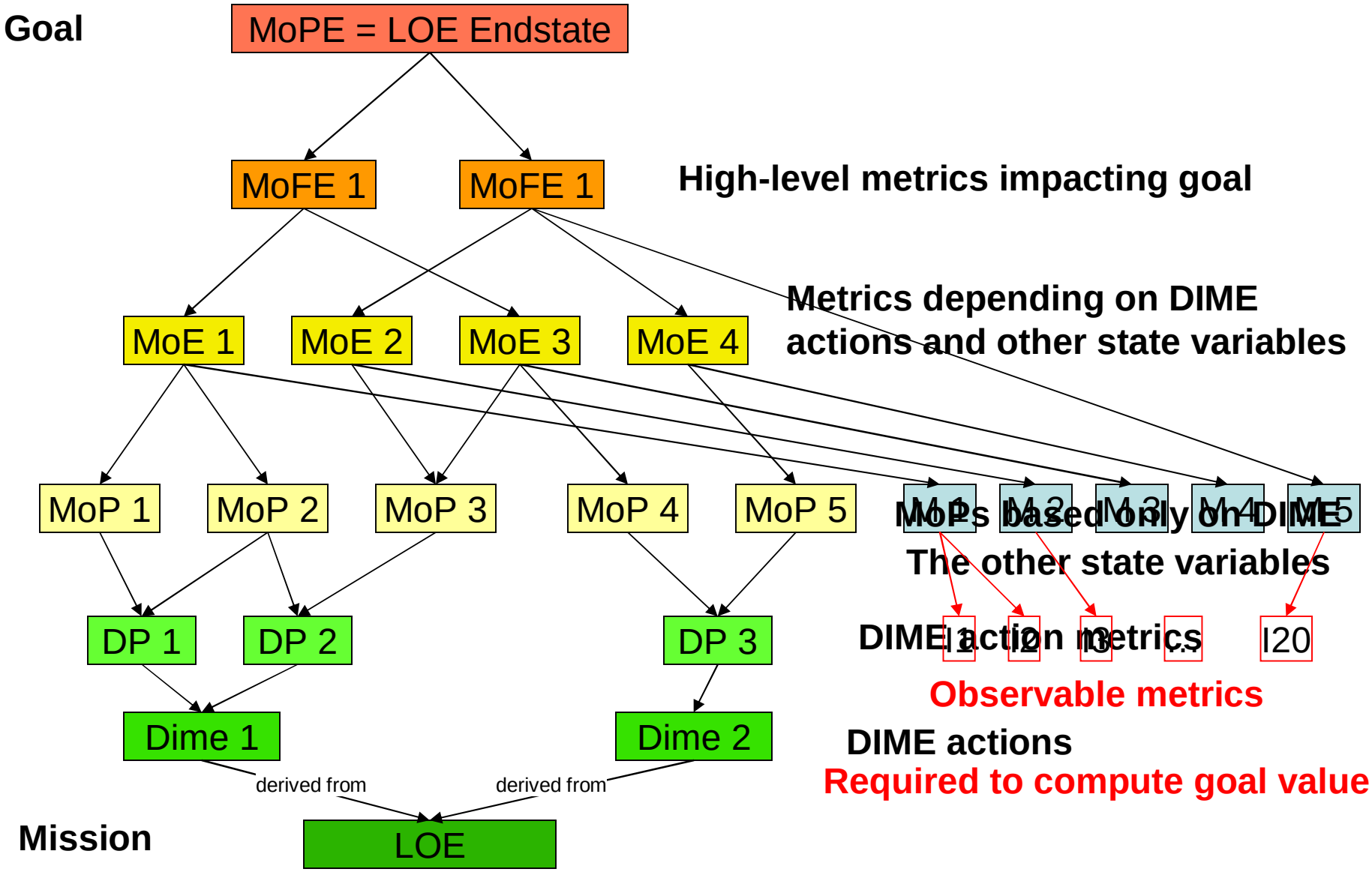
UML can be used to describe relationships between classes, properties, individuals/instances, and property values

How do we know what happened?

- Indicators … are not effects
- Better to be observable than not, but "not seen" does not mean "not there"
- Inference from indicator to effect is "reverse direction"

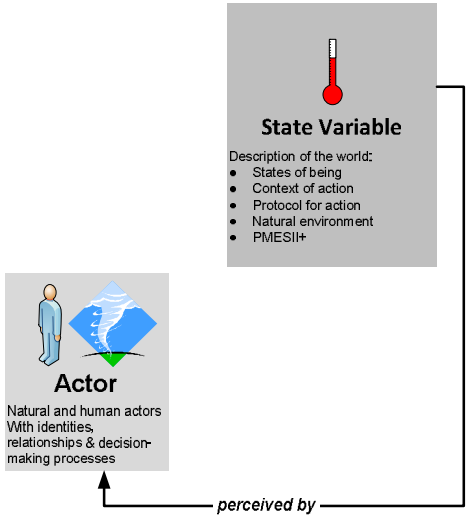


Observable Metrics for Deriving LOE Endstate



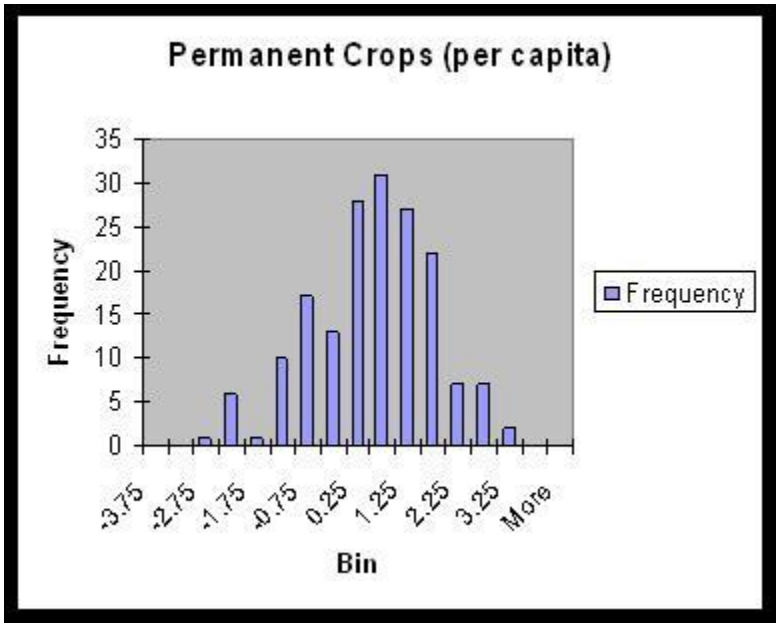
How are State Variables Calculated?

- Some state variables may be observed directly
- Most state variables will be calculated
  - Some state variables will be calculated from a single indicator/metric
  - Many state variables will be calculated from several indicators/metrics
- Most indicators/metrics will require reformatting
- Example: “Agriculture Sector Strength”
  - Indicator: Crop Production
  - Indicator: Meat Production
  - Combination: (CP+MP)/2
  - Scaling



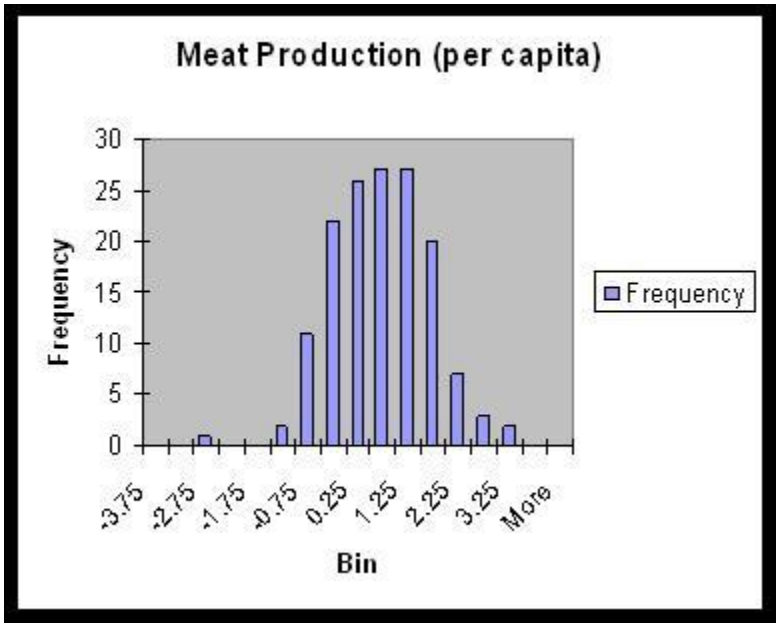
Crop Production

- Metric: Hectares of permanent crops per 1000 people
- Data from 175 countries
- Scaling equation to yield nearly normal distribution
  - ScaledCrops = 2*(log10(hectaresperKpeople)-1.1)



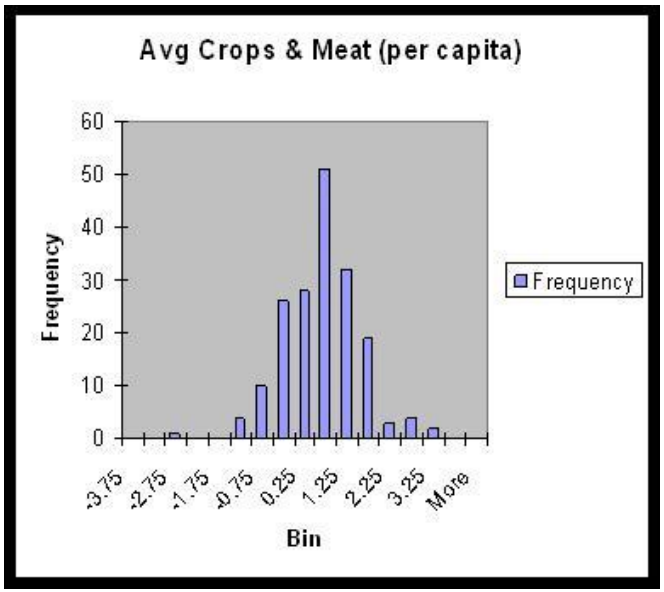
Meat Production

- Metric: Annual metric tons of meat per person
- Data from 150 countries
- Scaling equation to yield nearly normal distribution
  - ScaledMeat = 2*(log10(MetTonspercapita)+1.9)



Agriculture Sector Strength

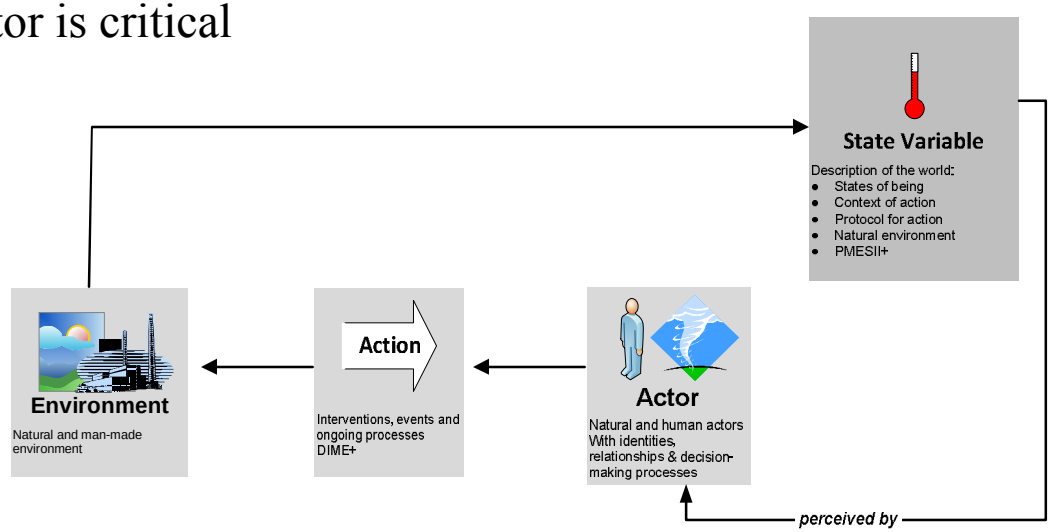
- First step
  - *AvgCrops&Meat* = (*ScaledCrops*+*ScaledMeat*)/2



- Second step: Calculate current figure for the country (use equations)
- Third step: Find the difference in standard deviations of the current figure from the international mean (a + or – number). Use this to represent the estimate of the current Agriculture Sector Strength
- Note: this is a model, not a fact

How are DIME Variables Calculated?

- DIME variables are both action variables and state variables
- As state variables, DIME variables represent the state of the action
- As action variables, DIME variables directly impact the environment, changing some state variables
- DIME variables are represented
  - Usually in two parts, an amount of work and an amount of work needed, that can be converted into a fraction
  - Sometimes as a fraction of completion, that can be scaled
  - Sometimes as a scaled variable, e.g., -3 to +3, representing "horrible" to "fantastic" total capability achieved
- Choosing the proper denominator is critical
- E.g., Electricity Production



Rebuilding Electrical Production

- In Iraq, electrical production capacity was destroyed in the war
- Reconstruction requirements were massive and required intermediate goals
- A construction project might involve building a megawatt generator
  - Beginning the project would involve purchasing materials and hiring and paying people
  - During the project, more materials would be purchased and people would continue to be paid
  - At completion, increased electricity would be produced, no new materials would be purchased and people would be laid off
- Project DIME variables
  - A DIME variable could be created that consisted of fraction of the project completed
  - Alternatively, a DIME variable could be created that consisted of amount of electrical production generated versus total capacity of the project
- A broader view would consider all construction projects in a phase
  - Create a DIME variable consisting of total work/total phase work
  - Create a DIME variable consisting of total electrical production/total electrical production desired from the phase
- A still broader view would consider all construction to restore production to pre-war levels
- The broadest view would consider all construction to create capacity that brings Iraq into a better than 3rd world status
- Note that
  - Red forces might destroy some work in progress, what does this do to DIME variables?
  - Red forces might destroy some electrical production capacity that was undamaged or completed in a previous project, what does this do?
- Which DIME variables are appropriate?

Prices as Metrics

- Price is determined by Supply, Demand, particular item, & other factors
- For an item, Supply & Demand are usually dominant
  - Price is proportional to Demand/Supply
  - Examples
    - Reduction in drug supply
      - Crop eradication
      - Drug interdiction
      - Capture or killing drug operatives
      - Raises price – **Metric says price increase is good**
      - May increase violent competition
    - Reduce demand
      - Education of buyers
      - Law enforcement against buyers
      - Lowers price – **Metric says price decrease is good**
      - May reduce competition as high price producers leave market
    - Do both
      - **Conflicting Metric interpretation**
- Measuring Supply and Demand directly is preferable – just harder

Context Diagram made Concrete

You (the Actor)

Cook (the Action)

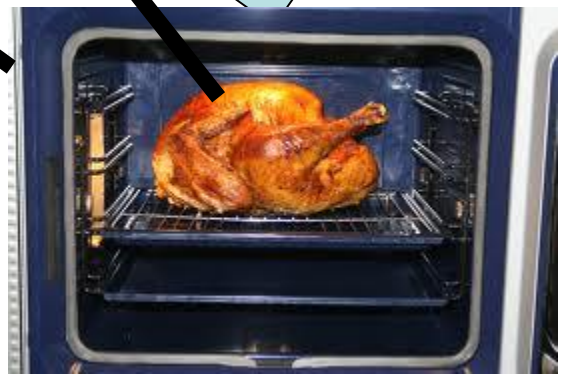
a Turkey in an Oven (collectively, the Environment)

and decide when to take it out with State Variables:

Example: Cooking a Turkey

Action: Put in Oven

Process: Cook



Indicator:
Cooking Time

Indicator:
Meat Temperature

MoM:
Turkey is done

Action: Take out of Oven

How Do We Get This Picture?

- Taking a raw turkey and putting it in the oven (almost always) results in "turkey is in oven"-state: fact
- Cooking the turkey (almost always) results in "turkey in oven is browner"-state: fact
- Taking a "cooked" turkey out of the oven (almost always) results in "brown turkey out of oven"-state: fact
- Desired Measure of Merit is "turkey is done"-state: given
- Connections among
  - "cooking time" and "turkey is done"
  - "meat temperature" and "turkey is done"
  - "cooking time" and "meat temperature"
  - model – subject to verification & validation
- Most MoMs are not directly observable, require models using observable indicators
- More complex MoMs use models with sub-MoMs and many indicators

Modeling Alternatives

- **Case 1: Situational Awareness**
  - **Monitor the indicators, when they say "go", intervene and eat the turkey**
  - **Requires analysis to develop a model of the relationship between the indicators and the MoM**
  - **The resultant model is (relatively simple), connecting observations of reality with the inferred MoM value**
- **Case 2: Simple Control Theory Model**
  - **Set the temperature, timer & thermometer, monitor for deviations. If the guests are late, turn down the temperature setting. If the guests are early and hungry, turn up the temperature setting.**
  - **Develop model of the relationships among the controls and the indicators, as well as a model between indicators and MoM**
  - **The resultant model is more complex than in Case 1; however, it still has simplifications. E.g., in IW case, Red actions and their results can be treated as indicators**
- **Case 3: Complex Model**
  - **Compute which controls actions will give the best results as the situation changes.**
  - **The relationship models need to be more complex and accurate, taking into account actor and action interactions and dynamics.**
  - **The resultant model is very complex.**

Sources of Concepts

Why We Need Authoritative References and Resources

- Ground concepts in vetted terms and definitions whenever possible
- Vetted terms and definitions have evolved from collaborative development and review
- Support provenance / pedigree of information in the ontology

IW References

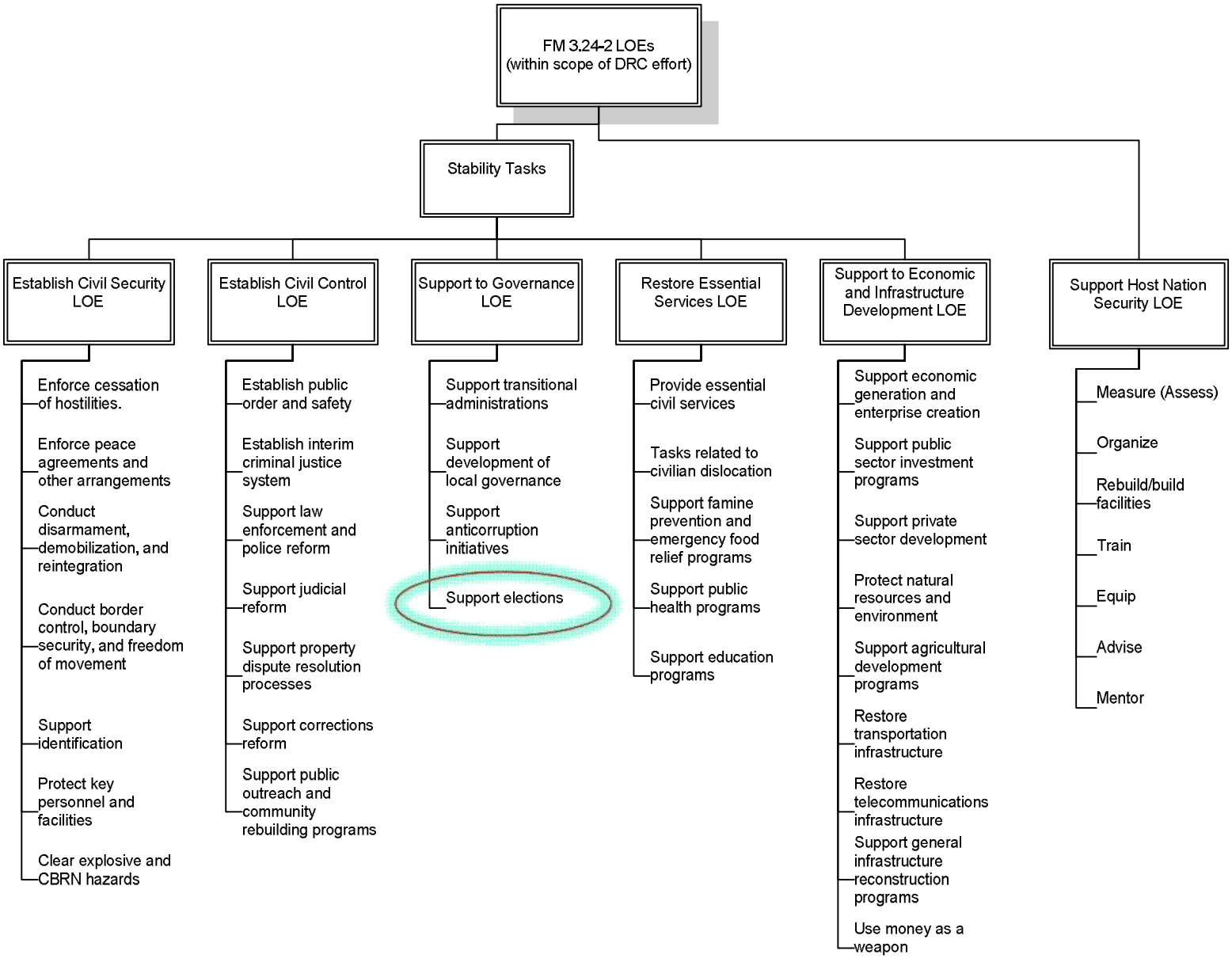
Descriptive Requirements (Actions, Effects, and Overarching)

#	Actions (79)					Effects (47)					
	Diplomatic	Information	Military	Economic	Legal	Political	Military	Economic	Societal	Information	Infrastructure
1	Support to Ambassador	Intell Ops on HN Conditions	Response to WMD Attack	Est Distro Ctrs for HA/DR	ID/Disrpt/Intrdict Funds: Dstbl	Δ in Pop Loyalty to HN Gov't	Foreign Sprt / Ops on HN Mil	Δ Dom Product (Sector, Region)	Foreigners on Norms & Behav	Info Collect on HN Gov't Actions	Essential Public Services on HN
2	Negots w/ HN Gov't	Intell Ops on HN Gov't	Response to Convent'l Attack	Build/Secure Lines of Comm	ID/Distrpt/Intrdict Inst'l Sprt: Dstbl	Δ Political Activity of Pop	Multi-Nat'l Exercises on Mil	Δ Flow of Capital	Quality of Life Perception	Info Gathering on HN Pop	Δ Infrastructure on HN
3	Negots w/ Local Leaders	Collect HN Citizen Percepts	Foreign NEO	Build/Secure Essent'l Services	ID/Distrpt/Intrdict Local Sprt: Dstbl	Δ Gov't Struct or Funct	Mil due to Ops	Δ HN Wealth / Income Distro	Restrictions on Pop Movement	Info Dissem on HN Gov't	Δ in HN Envirn
4	Embassy Comms	Info Dissem	Mil Training	Repatriate / Relocate Efforts	ID/Distrpt/Intrdict Recruit: Dstbl	Outside Involm't in HN Politics		Markets	Societal Leaders	Info Dissem on HN Citizens	
5	Improve HN Diplo Capability	Collect & Use of Refugee Info	Support to HN COIN Efforts	Econ Info Ops	Cntr-Criminal Syndicates Ops	Δ Percepts of Gov't Legit		Δ Avail/Cost of Goods/Services	Events: Stability & Security	3rd Party Media Percept/Attitude	
6	Diplo Acts: Prep for Stability Ops	Improve HN Gov't Comms	Mil Exercises	Mitigate WMD Effects	Martial Law & LE Ops	Δ Gov't Leadership		HR Training on Econ	Epidemic Breakout		
7	Comply w/ Int'l Conv'tns & Stds	Info Exchange Program	Logistics	Econ Intell Ops	Enforce Int'l Resolutions	Destabilizing Events		Combat Ops on the Economy	Migration		
8	Evac Embassy & Support Staff	Alter Influence of Ldrs	Improve of MoD	Est & Maint Log Support for HN	Cntr-Corrupt Activities	Trans-Nat'l Org's Acts (Internal)		NEO on Economy	Legislation, LE, & Regulations		
9	Negot Refugee Safe Havens	Δ Message / Position of Ldrs	Deter Foreign / Proxy Attackers	Improve Infrastructure	Improve Legal & LE Ministries	Outside Nation's Acts (Internal)		Econ Response to Rule of Law	Discrimination in HN		
10	Diplo Acts to Support HA/DR	Intell Collect to Support HN	Mil & Naval Presence	Econ Actions for Joint Mil Exer	Extra-Legal CriminalActs	HN by Forward Bases		Sanctions (Econ)	Terror / Insurgt Grps on HN Pop		
11	Diplo-Act for HN Gov't Pers Train	Improve HN Intell & IO	War & Mil Invasion	Hiring HN Citizens		3rd-Party Extrnl Diplo Acts		Industrialization on HN	Strikes, Protests, Riots, Gathering		
12	Diplo-Like Acts Btwn Orgs	ISR for Embassy		HA/DR Ops		Factional Group Activities		Trade Agreements			
13	Diplo Preps for WMD CM	HN Internal Dissem of Info		Est & Maint Refugee Camps				Δ HN Infrastructure			
14	Diplo Acts: Multi-Nat'l Exercises	Needs Assess for Decision-Making		Mitigate Destable Effects							
15	Diplo Aborgn'l, Nomad, Minority	Info Ops		Econ Dev for Disaster Recov							
16	Est Relatns: Absent a State	Training of HN Gov't Personnel		Stability Ops (Econ)							
17	Multi-party Diplo Negots			Improve MoI							
18	Destabilization Ops			Spending for HN MoI							
19	Deterrence			Spending for HN MoD							
20	Advocacy Acts by US Gov't			Spending for Rule of Law							
21	Security & LE for US			Spend / Dev HN Other Agencies							

Overarching (9+)						
States	Events	Actors	Decisions	Context	Protocols	Environment
PMESII Ground Truth	Time and Space	By Power or Authority (HN)	Hierarchical DM in Organizations	History	Social Norms & Expectations	Physical Terrains
Actor Percepts of PMESII	Events, Trends, & Cycles	By Region (Providence)	Individual Decision-making	Interpretation & Percept Rules	ROEs & Regulations	Natural Resouces
Historical States of Actors/Entities	Actions in Preparation for	By Ideology or Agenda	Social Process of Decision-making	Biases, Prejudices	Policies, Stds, Processes	Weather, Land Fertility
OPAL States of Actors	Weather Impacts to Decision-	By Social Identity (Tribe)	Perception of Environment,	Org Structs & Roles	Legal Rules & Procedures	Natural Physical Conditions
Current Rule Sets for Actors		By Interest (Unions)	Adapability & Learning	Limitations of Context Rules	Limitations of Protocol Rules	Physical Contraints
...	Implicit Req'ts	...		...	...	...

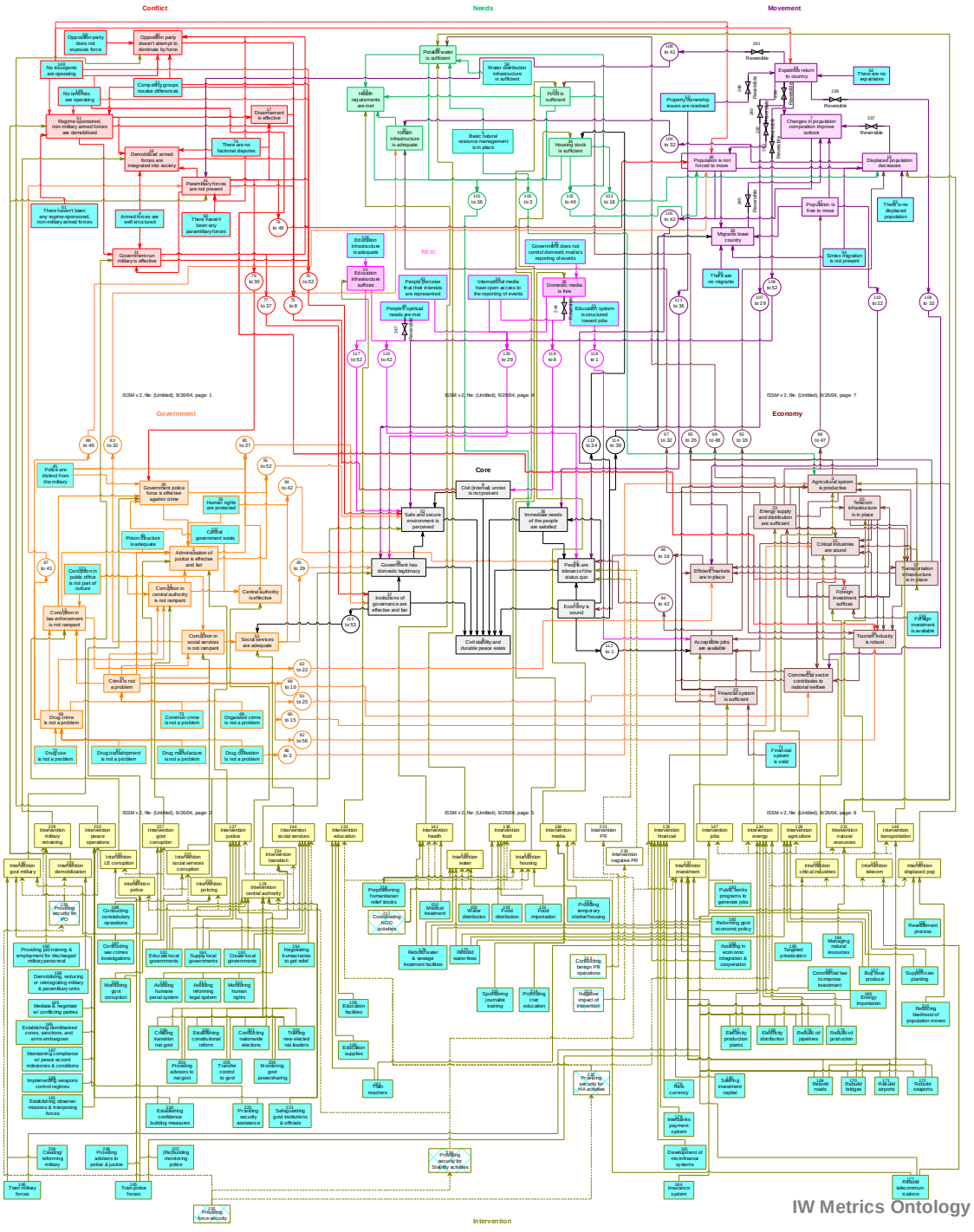
Source:
Smith, Young (2009) Requirements for a Government Owned DIME/PMESII Model Suite" (N81)

LOE Typical Tasks From FM 3-24.2

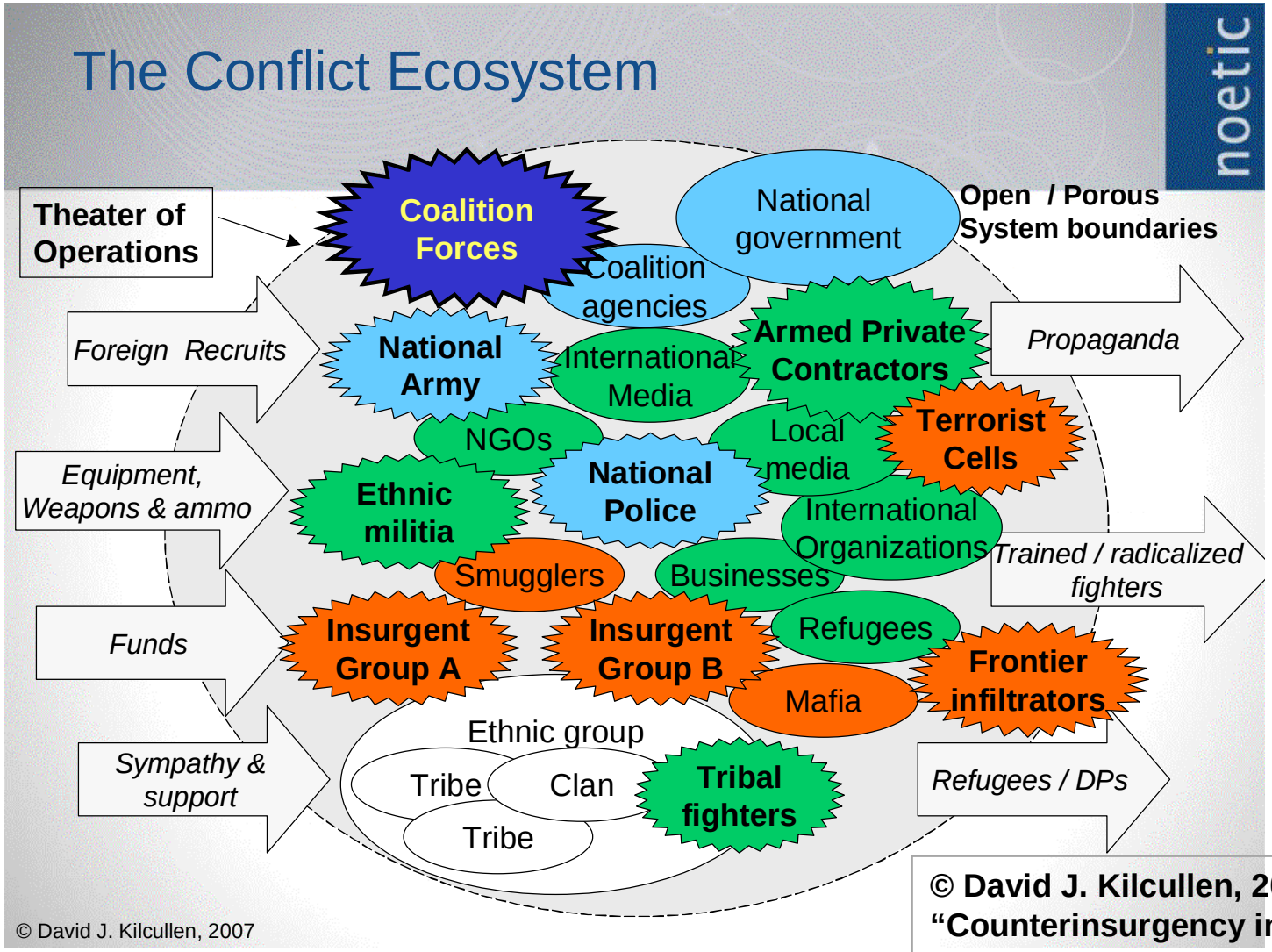


ISSM

We get our initial meronymy connections here, but not our hyponymy connections



Conflict Ecosystem

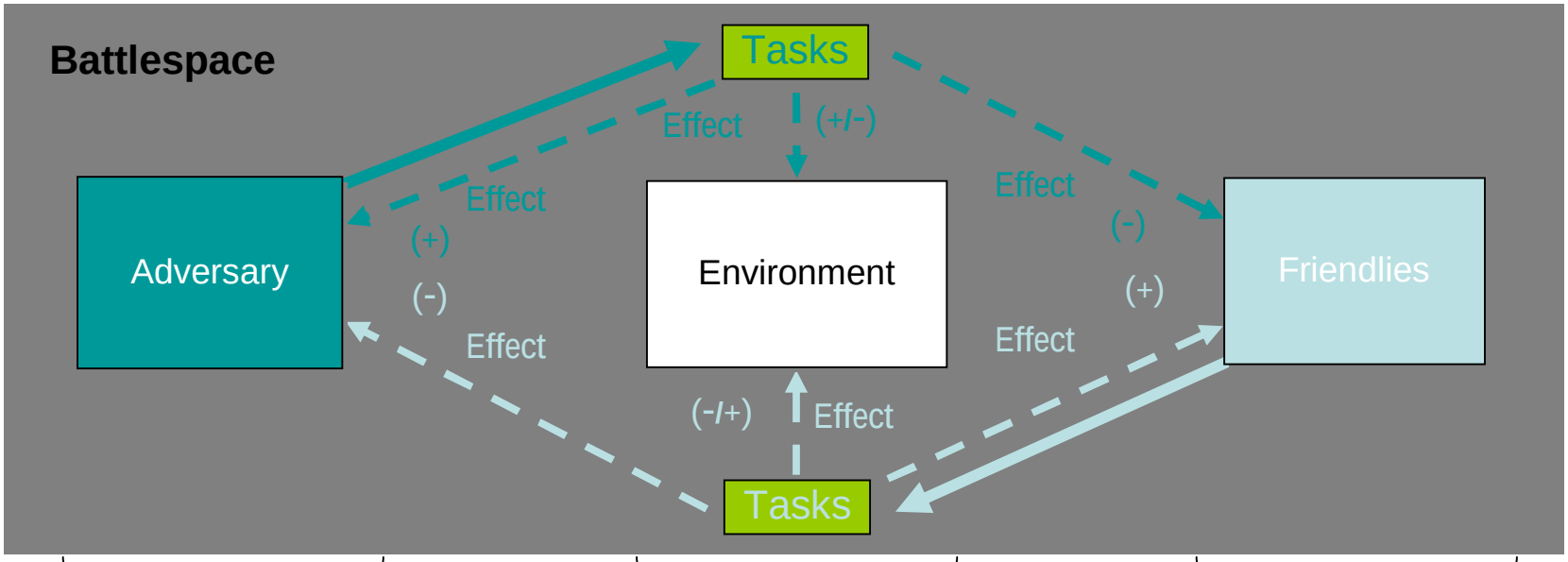


© David J. Kilcullen, 2007 from "Counterinsurgency in Iraq: Theory and Practice, 2007"

Operator's View

Source:
(Kiefer, 2004)

- **Performing *tasks* is a science – achieving desired *effects* is an art.**
- **The commander's CONOPs contains the broad flow of tasks to assigned units intended to achieve the desired effects and the required endstate. It is a theory that is tested in execution against an adversary and his CONOPs.**



Capability
- Means + Ways
- Freedom of Action
- Potential to Perform Tasks

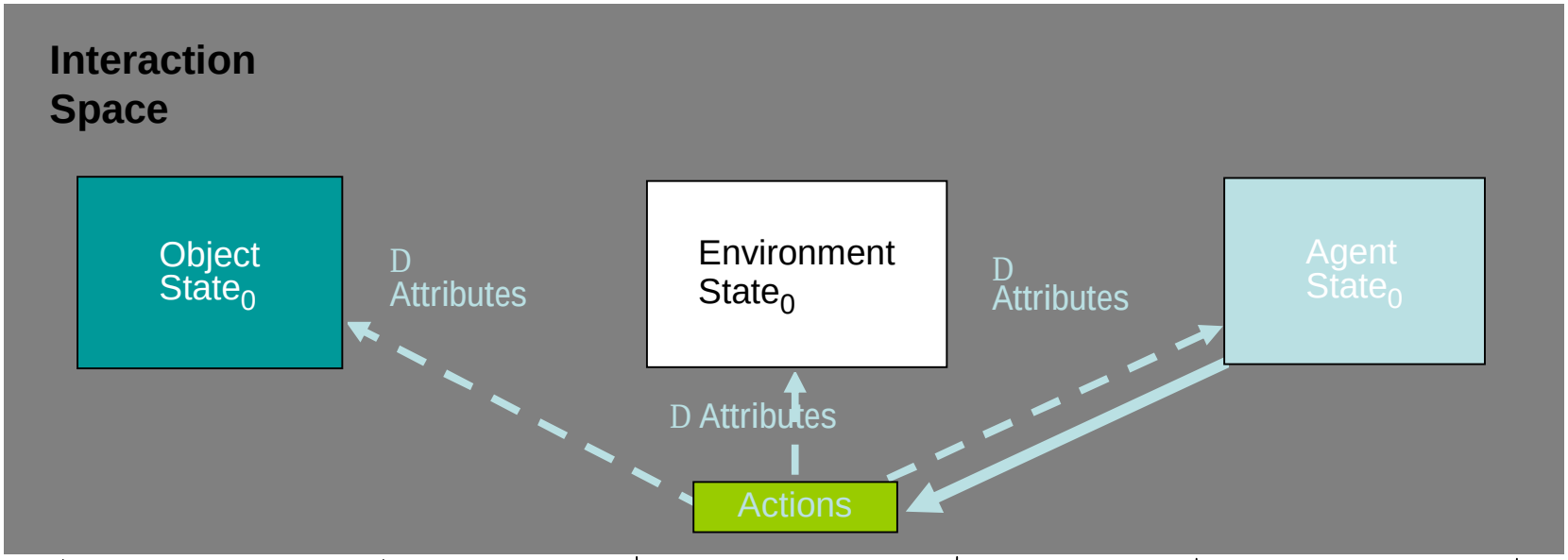
Conditions
- Affect Quality / Capacity of Task Performance

Capability
- Means + Ways
- Freedom of Action
- Potential to Perform Tasks

Data Architect's View

Source:
(Kiefer, 2004)

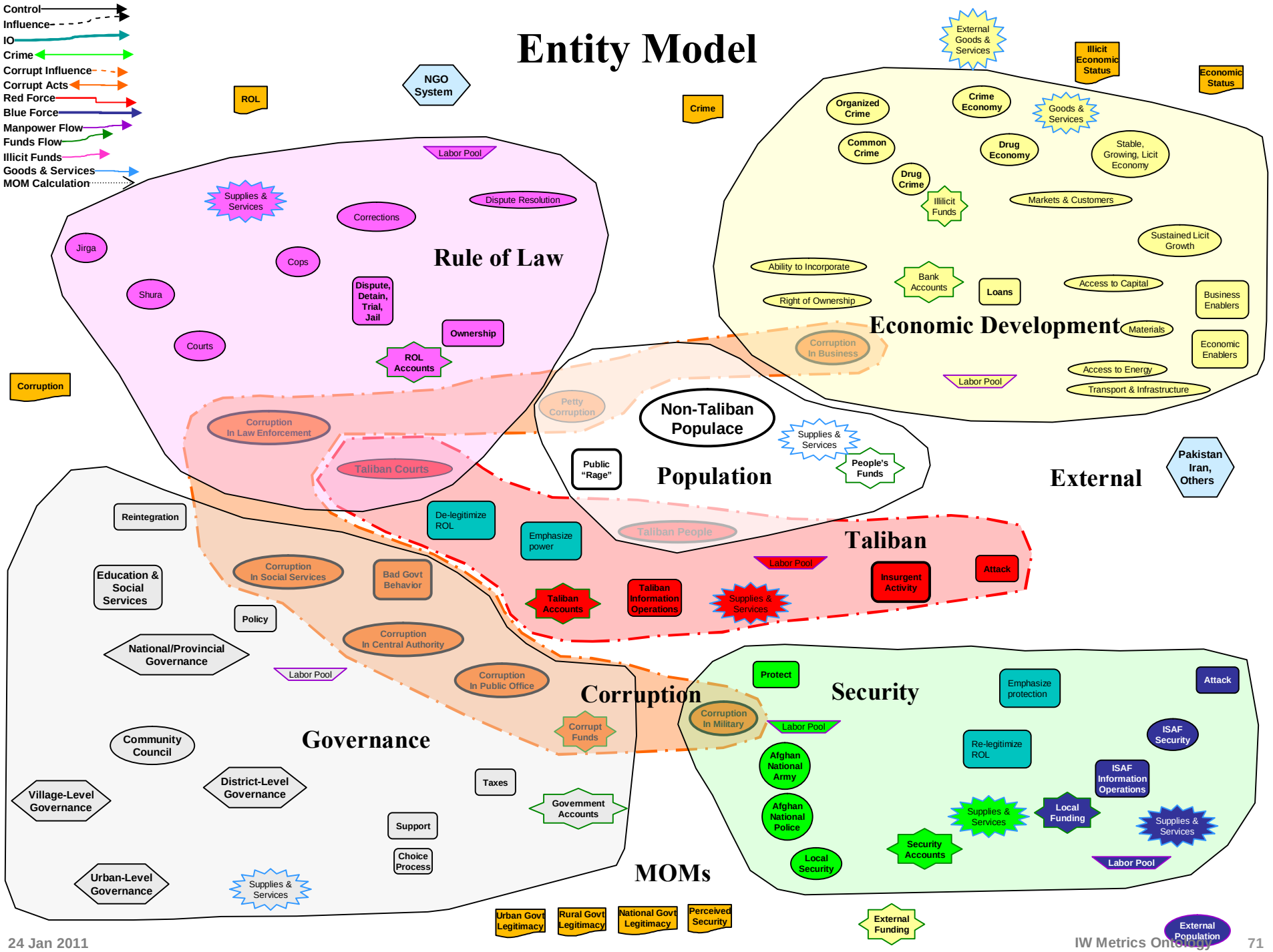
- State = set of elements + their attributes at a moment in time
- Actions change state by changing attributes (if conditions permit)
- A State Engine increments time; examines all elements and attributes; triggers actions and reactions whose state conditions are met; degrades or prohibits actions as limited by states; tests susceptibility state conditions of objects and, if met, changes attributes as a result of actions & reactions.



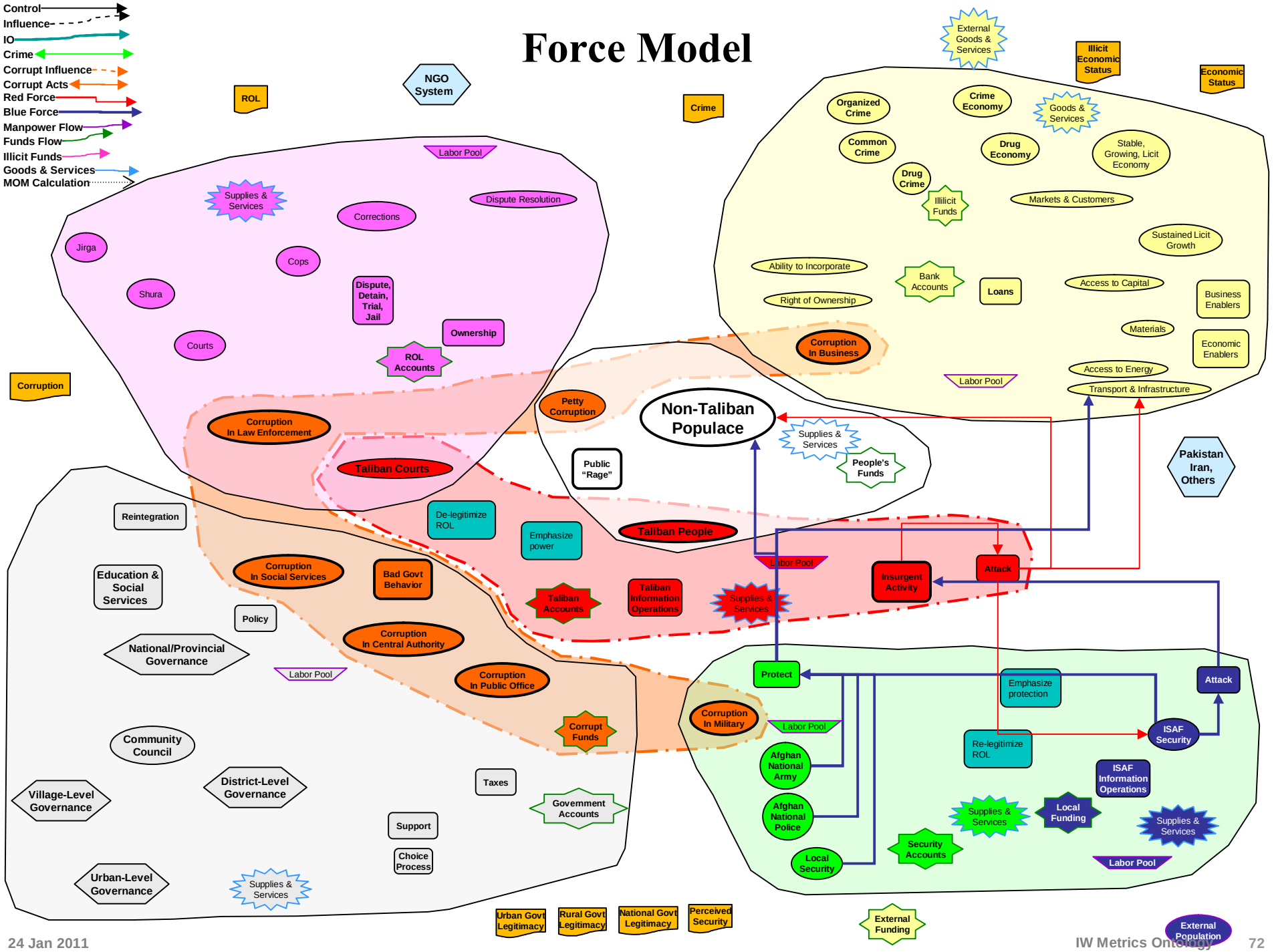
Object Susceptibility
- Elements & Attributes
- Reaction Queue
- Reaction Triggers
- Action Susceptibility Standards

Environment
- Elements & Attributes
- Action & Reaction Queue
- Action Standards
- Action Conditions

Agent Capability
- Elements & Attributes
- Action Queue
- Action Triggers
- Action Performance Standards


Control
Influence
IO
Crime
Corrupt Influence
Corrupt Acts
Red Force
Blue Force
Manpower Flow
Funds Flow
Illicit Funds
Goods & Services
MOM Calculation
Entity Model
NGO System
ROL
Crime
External Goods & Services
Illicit Economic Status
Economic Status
Rule of Law
Labor Pool
Supplies & Services
Dispute Resolution
Corrections
Jirga
Cops
Shura
Dispute, Detain, Trial, Jail
Courts
Ownership
ROL Accounts
Corruption
Economic Development
Organized Crime
Crime Economy
Goods & Services
Common Crime
Drug Economy
Stable, Growing, Licit Economy
Drug Crime
Illilicit Funds
Markets & Customers
Sustained Licit Growth
Ability to Incorporate
Bank Accounts
Loans
Access to Capital
Right of Ownership
Business Enablers
Materials
Economic Enablers
Corruption In Business
Labor Pool
Access to Energy
Transport & Infrastructure
Petty Corruption
Non-Taliban Populace
Supplies & Services
People's Funds
Public "Rage"
Population
External
Pakistan Iran, Others
Corruption In Law Enforcement
Taliban Courts
Reintegration
De-legitimize ROL
Emphasize power
Taliban People
Taliban
Education & Social Services
Corruption In Social Services
Bad Govt Behavior
Labor Pool
Attack
Insurgent Activity
Taliban Accounts
Taliban Information Operations
Supplies & Services
Policy
National/Provincial Governance
Corruption In Central Authority
Labor Pool
Corruption In Public Office
Corruption
Protect
Security
Emphasize protection
Attack
Corruption In Military
Labor Pool
Corrupt Funds
Community Council
Governance
Re-legitimize ROL
ISAF Security
Afghan National Army
ISAF Information Operations
Village-Level Governance
District-Level Governance
Taxes
Afghan National Police
Supplies & Services
Local Funding
Supplies & Services
Government Accounts
Support
Security Accounts
Choice Process
Local Security
Labor Pool
Urban-Level Governance
Supplies & Services
MOMs
Urban Govt Legitimacy
Rural Govt Legitimacy
National Govt Legitimacy
Perceived Security
External Funding
External Population

Force Model


Control
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Bank Accounts
Loans
Access to Capital
Business Enablers
Right of Ownership
Materials
Economic Enablers
Corruption In Business
Access to Energy
Transport & Infrastructure
Labor Pool
Labor Pool
Supplies & Services
Dispute Resolution
Corrections
Jirga
Cops
Shura
Dispute, Detain, Trial, Jail
Courts
Ownership
ROL Accounts
Corruption
Petty Corruption
Non-Taliban Populace
Corruption In Law Enforcement
Supplies & Services
People's Funds
Pakistan Iran, Others
Taliban Courts
Public "Rage"
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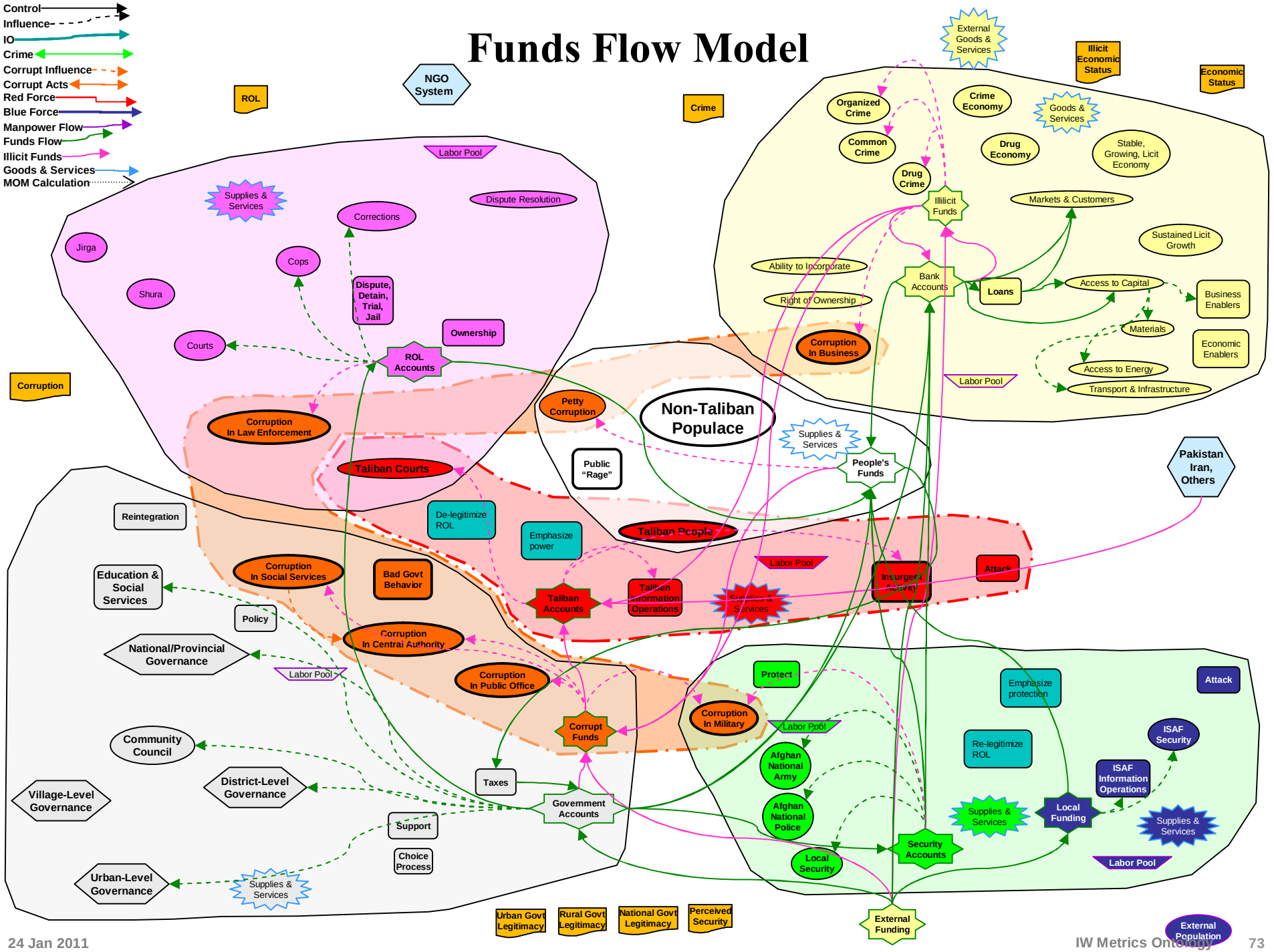
De-legitimize ROL
Emphasize power
Taliban People
Education & Social Services
Corruption In Social Services
Bad Govt Behavior
Taliban Accounts
Taliban Information Operations
Supplies & Services
Insurgent Activity
Attack
Policy
National/Provincial Governance
Corruption In Central Authority
Labor Pool
Corruption In Public Office
Protect
Emphasize protection
Attack
Corruption In Military
Corrupt Funds
Labor Pool
Re-legitimize ROL
ISAF Security
Community Council
Afghan National Army
ISAF Information Operations
Village-Level Governance
District-Level Governance
Taxes
Afghan National Police
Supplies & Services
Local Funding
Supplies & Services
Government Accounts
Support
Security Accounts
Choice Process
Local Security
Labor Pool
Urban-Level Governance
Supplies & Services
Urban Govt Legitimacy
Rural Govt Legitimacy
National Govt Legitimacy
Perceived Security
External Funding
External Population

Funds Flow Model



Potential Sources for Ontology Elements

Identify Ontology Reuse Candidates

A2

Citation	Reference
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Hilson	**Roger Hilson, et al., *Requirements for a Government Owned DIME/PMESII Model Suite*. Office of the Secretary of Defense Modeling & Simulation Steering Committee, Washington, DC. 2009.**

Doctrine

Strategic/Operational Level

- US Government COIN Guide
- IW Joint Operating Concept
- JP 3-24
- Joint Doctrine Pub 3-40
- FM 3-0
- FM 3-24
- FM 3-07

- Tactical Level
  - FM 3-24
  - FM 3-07
  - FM 3-07.1
  - FM 3-24.2
  - CALL Leader's Handbook 07-27
  - CALL PRT Playbook

From: (Azimuth, 2010)

IW Metrics Lexicon

- JP 1-02, DOD Dictionary of Military and Associated Terms, 12 April 2001, as amended through September 2010
- Some terms identified as part of Capabilities Based Planning
- Some terms identified as part of MORS workshops
- Other terms will be defined as part of ontology development effort

CBP Data Architecture Primitives

- Element: a physical or mental thing that exists. (noun)
- Attribute: a quantitative or qualitative characteristic of an element or its actions. (adjective or adverb)
- Action: A behavior by an element that changes the state of any element. (verb)
- State: the set of attributes an element possesses at a point in time.

From: (Kief, 2004) derived from (Dubois, 1997)

CBP Terminology for Operators

- Terminology discussed at MORS CPB Workshops

  - Mission: purpose (objectives and endstate) assigned to the commander.
  - Endstate: set of conditions, behaviors, and degrees of freedom that defines achievement of the commander's mission.
  - Effect: a change in a condition, behavior, or degree of freedom.
  - Capability: ***"The ability to achieve a desired effect under specified standards and conditions through combinations of means and ways to perform a set of tasks"***
  - Task: an action or activity (derived from an analysis of the mission and concept of operations) assigned to an individual or organization to provide a capability
  - CONOPS: overall picture and broad flow of tasks assigned to subordinates/supporting entities within a plan by which a commander maps capabilities to effects to accomplish the mission for a specific scenario.
  - Scenarios: assumptions about the political-military context, including the adversaries, friendlies, and neutrals.
  - Conditions: variables of the operational environment including scenario that affects task performance.
  - Standards: quantitative or qualitative measures for achieving the levels of performance of a task

From: (Kief, 2004) and updated at (MORS, 2007)

CBP Terminology for Data Architects

- Classes: physical/mental (all), agent/object (elements only)
- State: the set of attributes an element possesses at a point in time
- Capability: the set of all actions that an agent element may take as permitted by its state.
- Susceptibility: the set of all actions that can change an attribute of an object element as permitted by its current state.
- Condition: a range of states that affects performance of an action or an action's impact on changing an attribute.
- Standard: the proficiency and sufficiency specified for performance of a task.
- Effect: a state change
- Endstate: the state that defines achievement of the commander's mission.
- Metric: quantitative measure associated with an attribute.

From: (Kief, 2004)

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