Operational Threat & Risk Information Sharing and Analytics

TEAM Threat

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Where Business Meets Technology

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LOCKHEED MARTIN

Introduction

Topic:

Operational threat and risk conceptual model and mappings standards process

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Organization:

Object Management Group

www.omg.org

Resources:

www.threatrisk.org

Government Sponsor

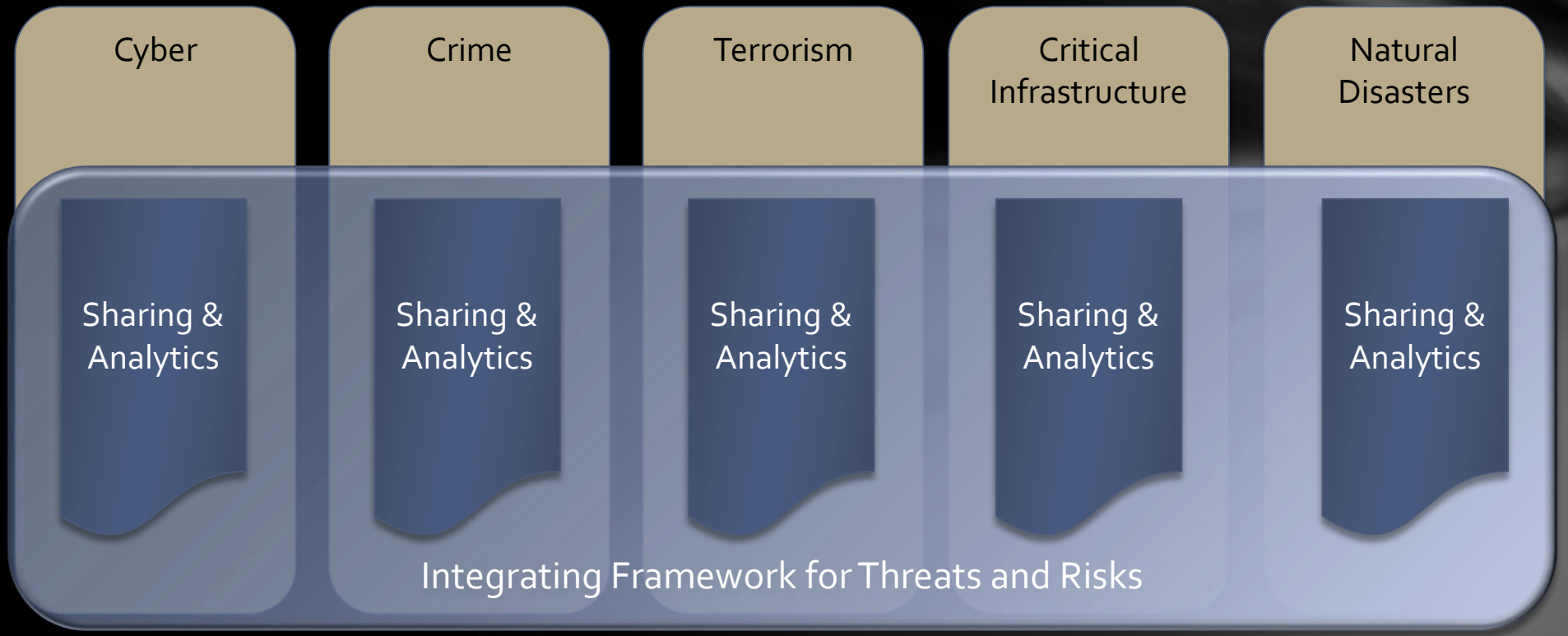
Information Sharing Environment

www.ise.gov

Problem Space

- There is a critical need to understand and mitigate threats and risks – to "connect the dots".
- The Landscape of threats is changing
  - Multiple attack vectors, cyber/physical and other
  - Advanced threats utilize multiple vulnerabilities
- There are multiple communities addressing the same threats
  - Cyber/physical, emergency management, safety, defense, etc.
- No comprehensive consistent semantic framework
  - Existing systems provide insular treatment of threat/risk relationships
  - Comprehensive system would allow system-of-systems interoperability (private/private, public/private)

What we need is an integrating framework that supports automated data mapping



An integrating framework that helps us deal with all aspects of a risk or incident

A federation of risk and threat information sharing and analytics capabilities

Example Information Flows

Suspicious Activity Report

NIEM Incident

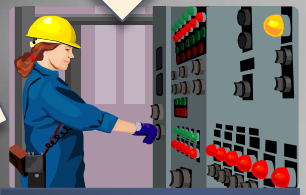
Arrest Report

STIX Incident

Fusion Center Intelligence Report

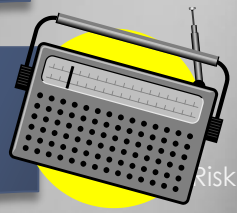
Tactical Response Unit

IT System Hardening



Manual Shutdown

Public CAP Warning



Primary classes of use cases

Transformation from one information sharing data format to another

- Example: STIX Cyber Event to NIEM to a CAP Alert

Analytics of information federated from multiple sources

- Examples:
  - Fusion center "connects the dots" between a stolen laptop (from NIEM) and a cyber incident (From STIX)
  - Bio hazard detected by automated instruments and collaborated by local health care professionals

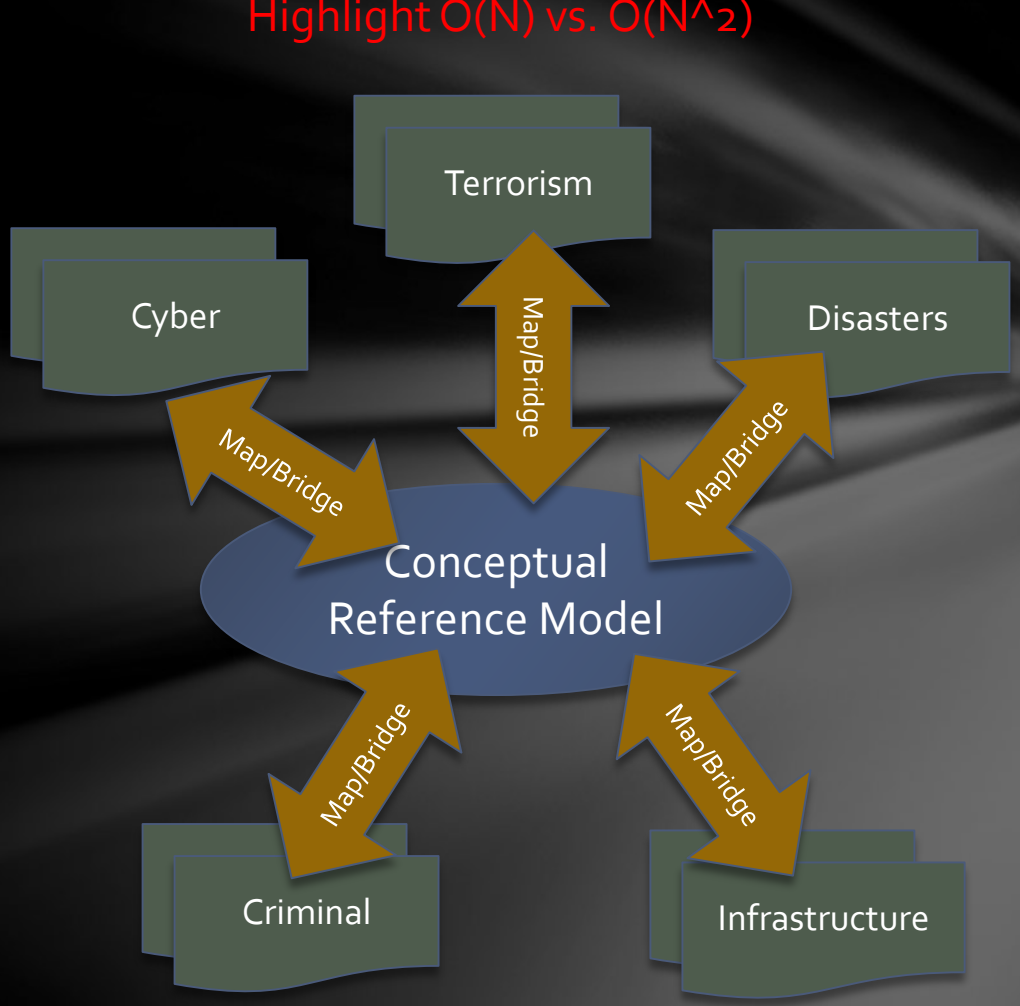
Approach

Construct a conceptual reference model informed by existing schema, research and best practices

- This conceptual model is independent of specific data structures, technologies and terminologies

Define mapping models between the conceptual model and purpose/technology schema

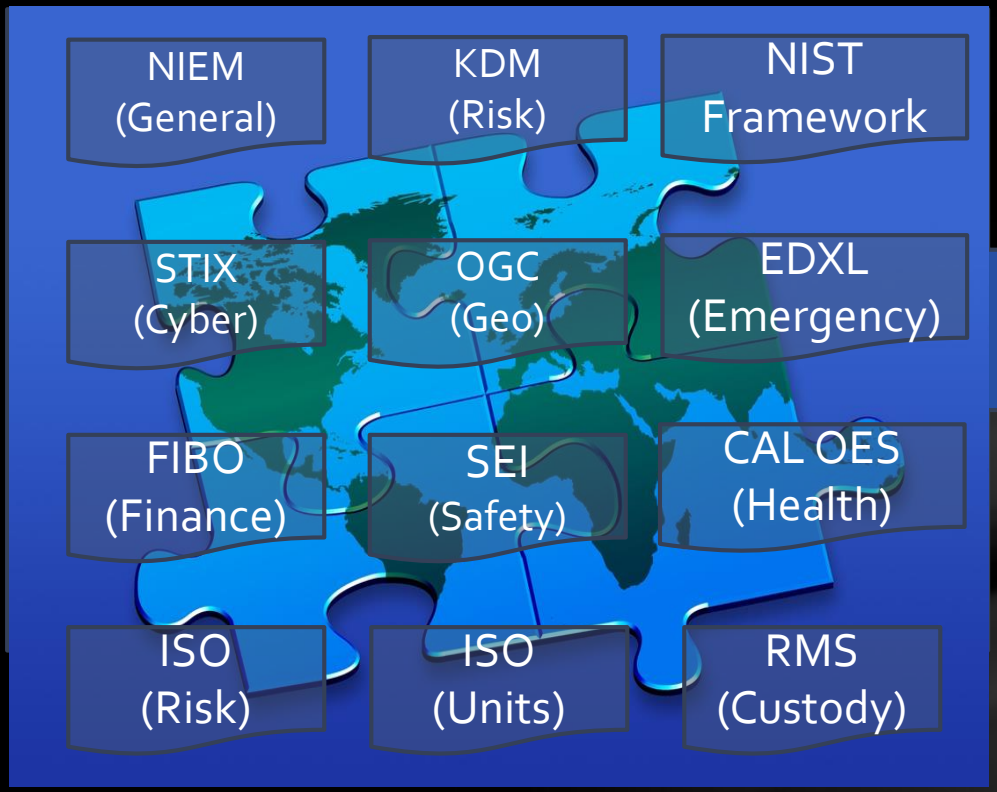
Make both models sufficiently precise that they can drive automated bridging between any mapped schema



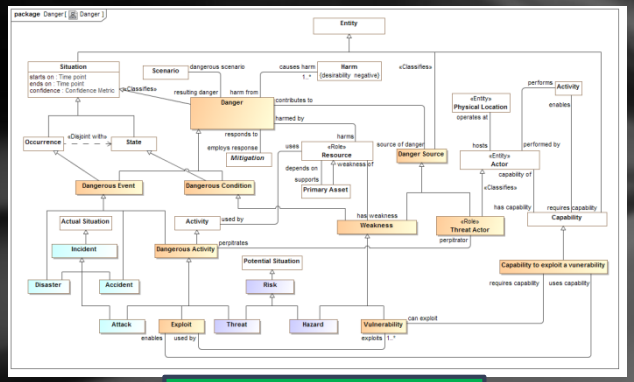
Precepts

- The purpose/organizational/technology specific schema will not (should not) go away
- A "one size fits all" solution will not work
  - There will be no one technology
  - There will be no one terminology or language
  - There will be no one data structure for threats and risks
- Our focus is federation
  - Understanding the concepts behind the schema
  - Mapping them to/through a common conceptual model
  - Enabling interoperability by bridging between the specific schema
  - Supporting integration and coordination of mitigation and response capabilities

Conceptual Model Inputs



Conceptual Reference Model



MAP

STIX, NIEM, EDXL, Others

There is still more to do to fully integrate the above and we anticipate more inputs and use cases

Realization

This "conceptual reference model" orientation is really quite different from defining a model or ontology for a specific purpose or application!

Mappings included

STIX – Structured Threat Information Exchange, for Cyber threat information. (Moving to Oasis "CTI")

NIEM – National Information Exchange Model – For justice, public safety and other domains.

Risk Model – A concrete risk model for data interchange is included and mapped as none currently exists as a standard.

NIST 800-53 – Security and Privacy Controls for information systems. This is not a data mapping but shows how the concepts support the controls.

Note: More mappings are anticipated as the initiative unfolds. Some may be published but not standardized.

Ontological Challenges

"Temporal aspects" of all relationships and situations is important. Not understanding these temporal aspects could result in error.

- The threat/risk model incorporates temporal aspects into the core of the ontology and language. All situations and relationships are temporal. In OWL and other FOL based languages this requires reification.

Provenance of every "fact" is crucial to trust.

- Due to the reification, metadata can be attached to every assertion.

Different communities and systems use different ways to represent the same thing or occurrence in the world.

- The threat/risk model is a model of a real (or possible) world, not data. These concepts provide a pivot point between different data representations that are then **mapped**.

What something is and the roles it takes in various situation gets conflated.

- "Role" is a "first class" concept – something or someone may play different roles at the same or different times

The world has time and context – not "first order"

- We represent the real-world concepts. What and how to reason is derived by mappings.

Various levels of detail and precision for different stakeholders (expert view is not intuitive)

- We try for a happy medium, where the expert concepts are simplified

Pivoting Through a Reference Model

Data representations (Schema & Instances)

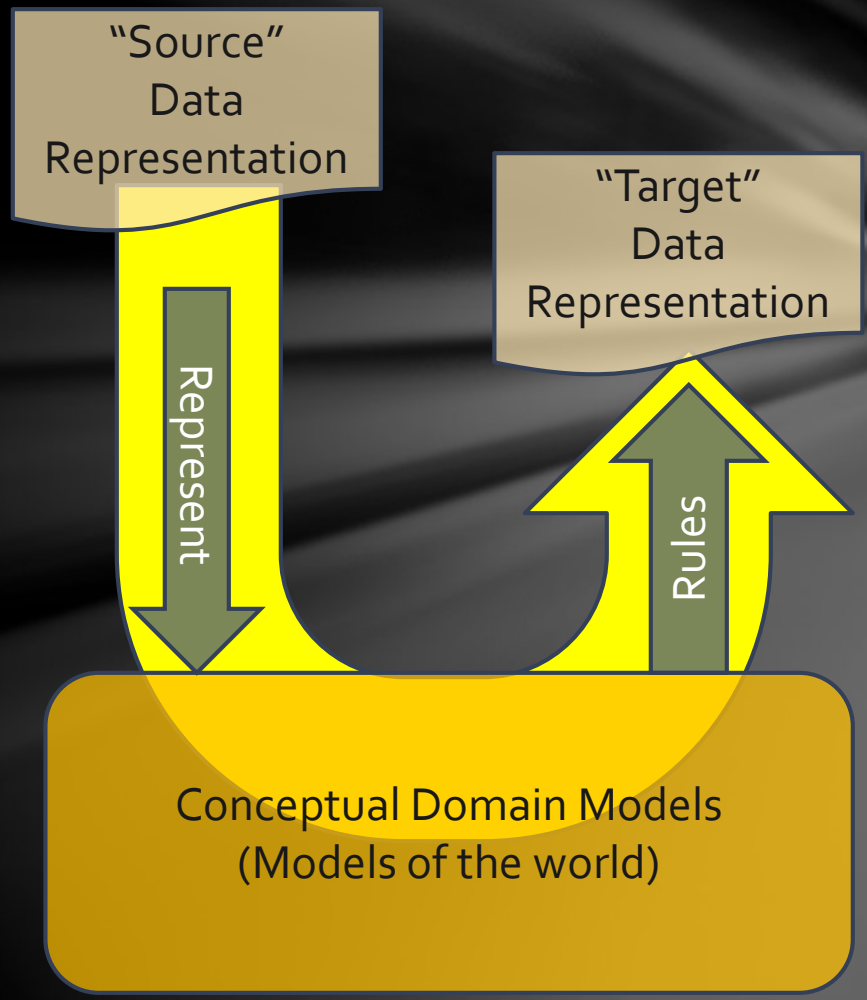
- Model data for a purpose using a technology
- "Instances" are data structures (e.g. SQL tables or XML documents) – "facts" about the things in the world from some perspective

Conceptual Reference Models

- A conception of the world by a group of stakeholders – less purpose specific
- "Instances" are things in the world – so can't be in models

Using abstraction, we can have multiple representations of facts about the world in different data structures and technologies

Rules define how domain concepts can be represented in a particular form – rules can be simple and generic or heavyweight and specific, depending on the representation.



Kinds of models

Conceptual Reference Models

- Defines the terms and concepts of the threat & risk domain as a semantic model. Conceptual models can also be transformed to ontologies.

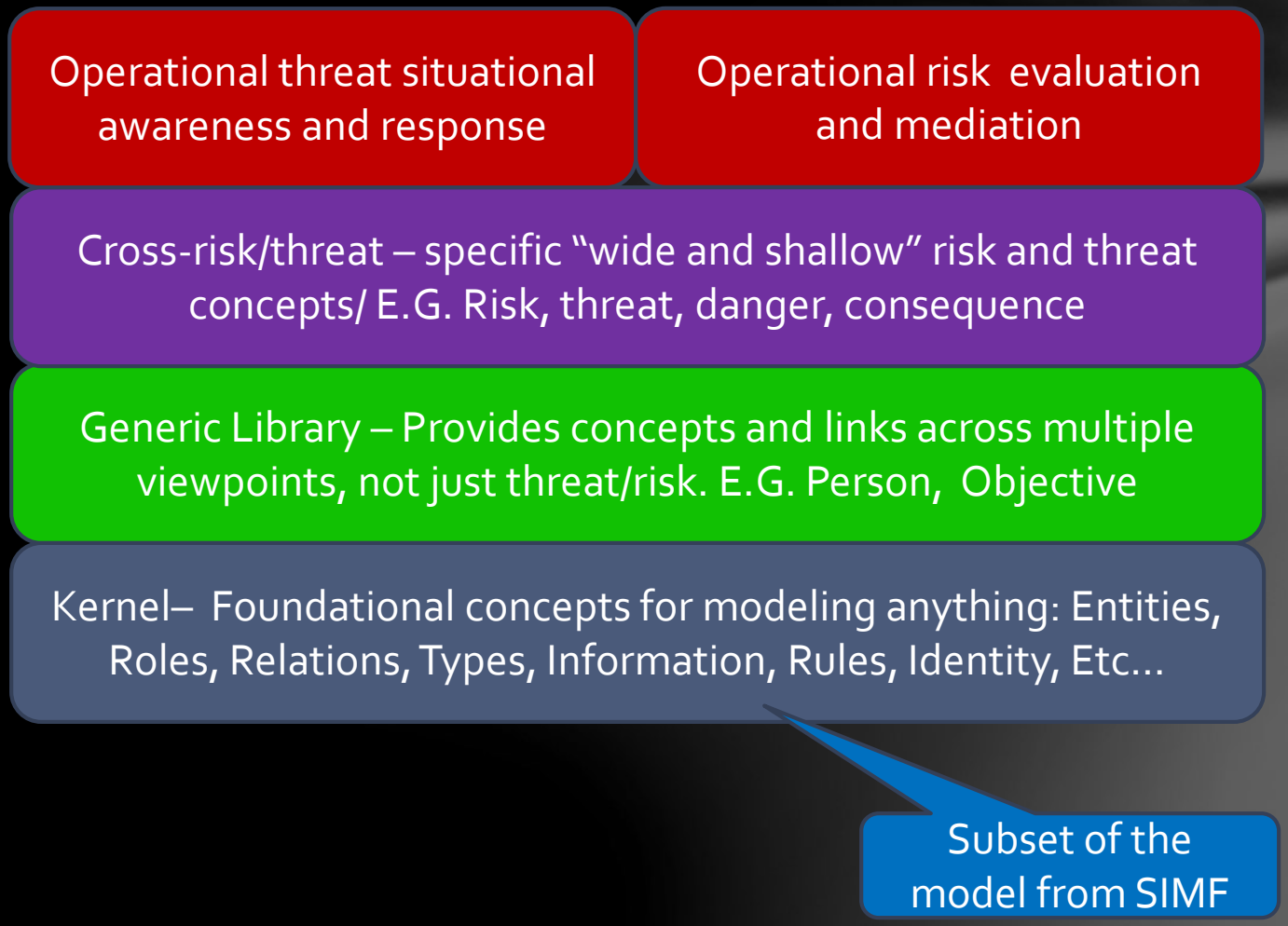
Data models

- Represents specific logical or physical data schema for a specific purpose – more concrete and structured.
- Data models are a direct representation of some kind of schema, e.g. XML Schema, SQL Schema or RDF Schema.

Mappings

- Mappings relate a data model to one or more conceptual models to provide for automated transformation and federation of information in these deferent formats.
- The conceptual models become the "pivot point" between multiple data representations of the same and related concepts.

Conceptual Model Layering



Conceptual Model Packages

Generic Concepts

Abilities

Actors

Assessment

Contact Information

Containment

Control

Credentials

Cyber

Enterprise

Entities

Events and Activities

Identifiers

Intent

Location

Objectives

Observations

Generic Concepts

Organizations

Patterns

Persons

Physical Entities

Places

Policies

Predictions

Processes

Quantities and Units

Resources

Responsible Performers

Rules

Situations

Time and Temporality

Vendors and Producers

Threat and Risk Specific Concepts

Campaigns

Danger

Danger Categories

Danger Sources

Incidents and Failures

Indicators

Risk

Risk Treatment

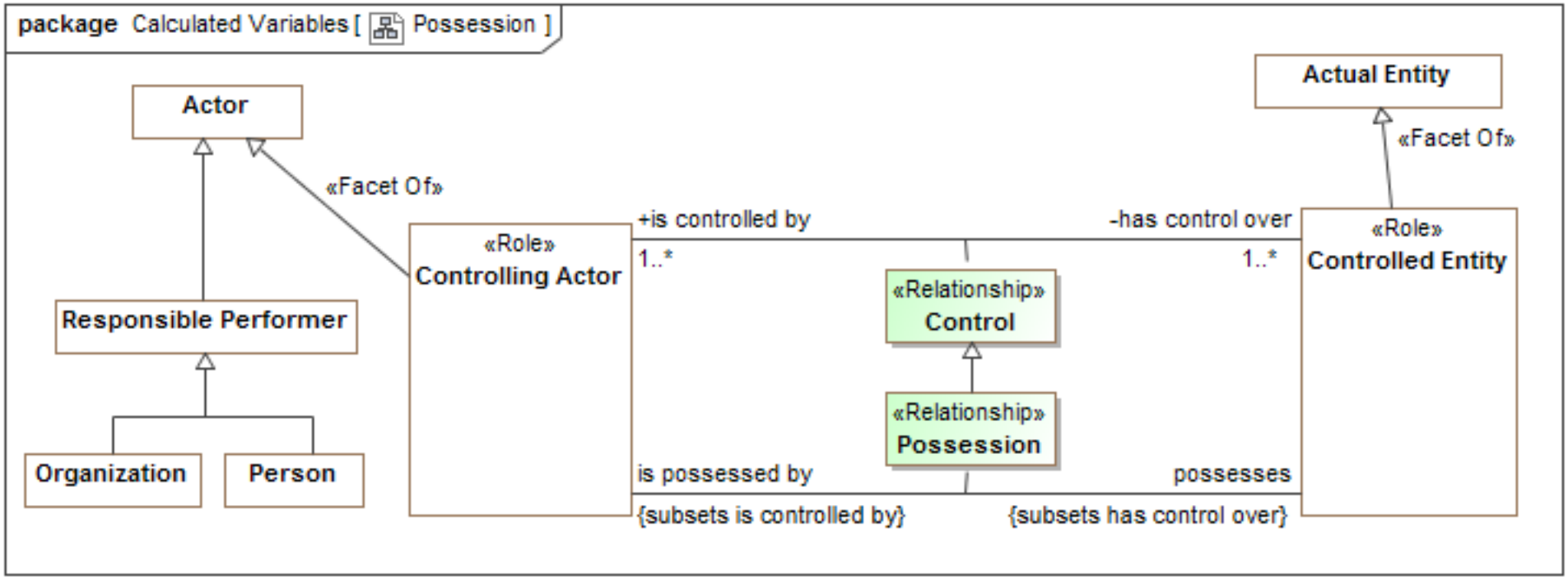
Threat Actors

Undesirable Situations

Vulnerabilities

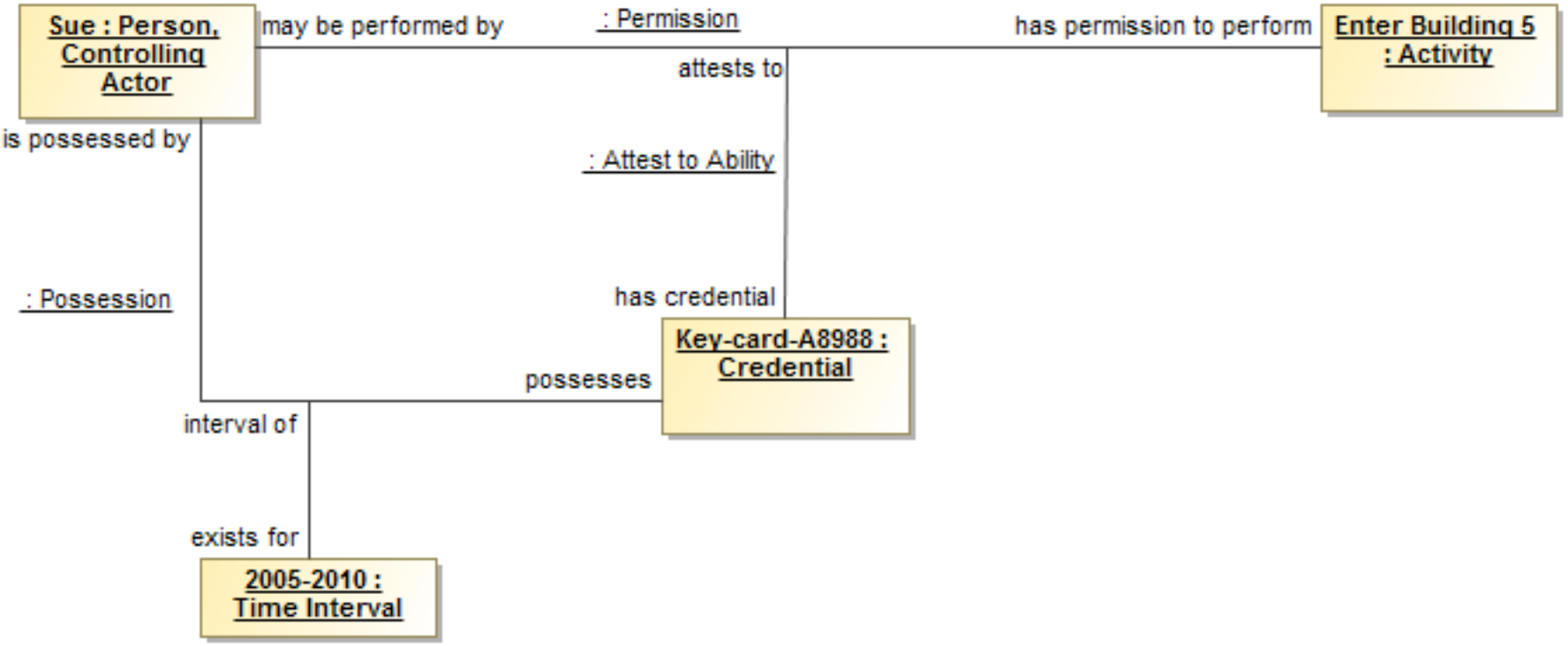
Weapons

Example of Modeling Style



- Control Possession relationships are "first class" – have a timeframe, can be part of cause and effect, etc.
- "Controlling Actor" is a role – people and organizations can play this role
- Both entity classes and relationships form hierarchies
- There are multiple ways "data structures" could be arranged to represent this information or a subset of it – that is the subject of mappings.

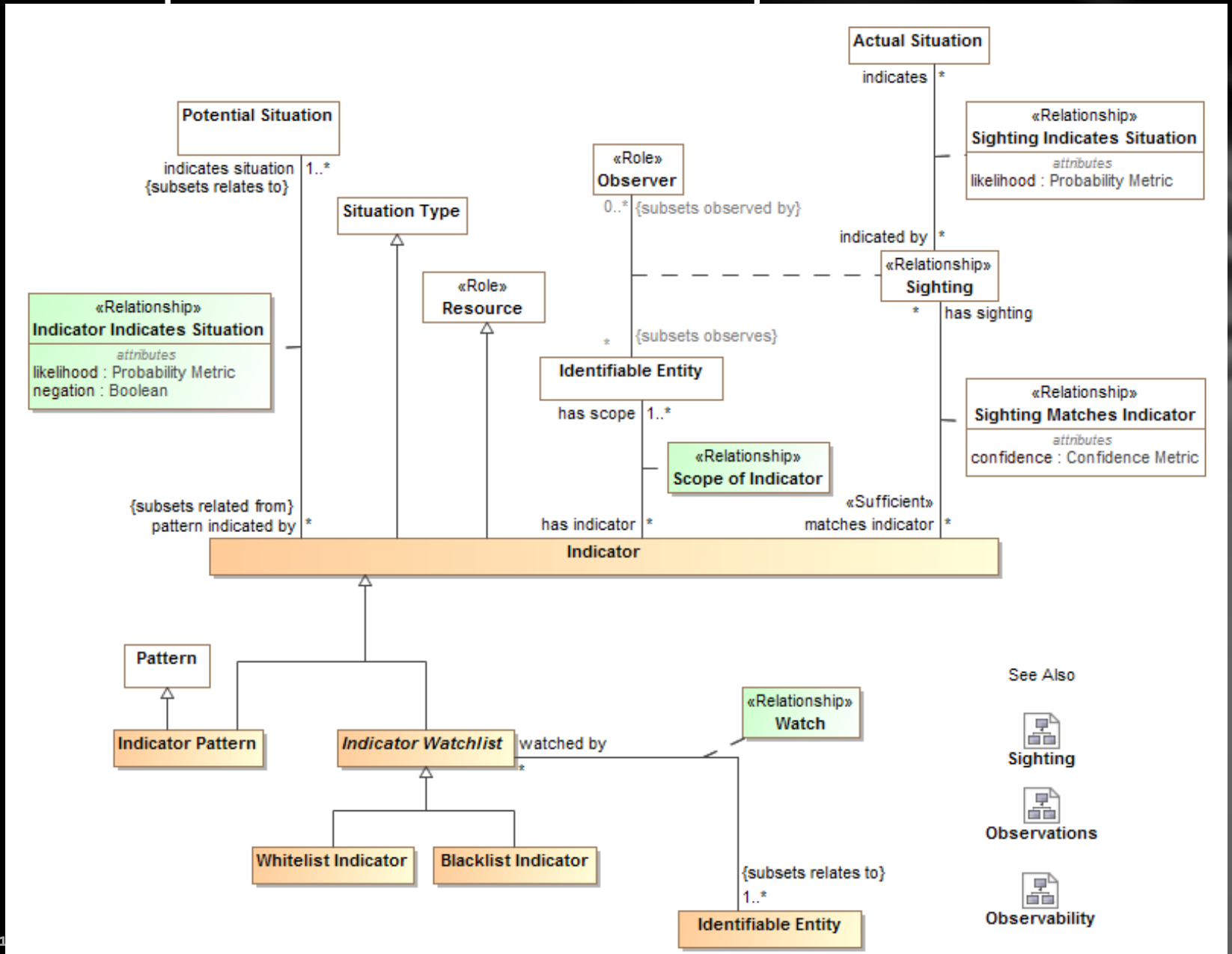
Example Instances



In the time interval from 2005-2010 Sue <possesses>"Key-card-A8988" that <attests to> the permission: Sue <has permission to perform> "Enter Building 5".

Note: Note the best notation; this is intended to validate the model using UML.

Example of more threat-specific module



Model/Ontology/Vocabulary Representation

Operational Threat/Risk uses the in-progress "Semantic Information Modeling for Federation" (SIMF) specification, being developed in the OMG.

SIMF defines a foundational semantic conceptual model for the modeling language as well as a UML (Unified Modeling Language) profile.

The UML Profile is what has been shown, using the "Cameo Concept Modeler" from Nomagic.

Based on the (draft) specification, CCM is able to generate OWL for the threat/risk model. Other implementation technologies could be generated as well.

Data Mappings

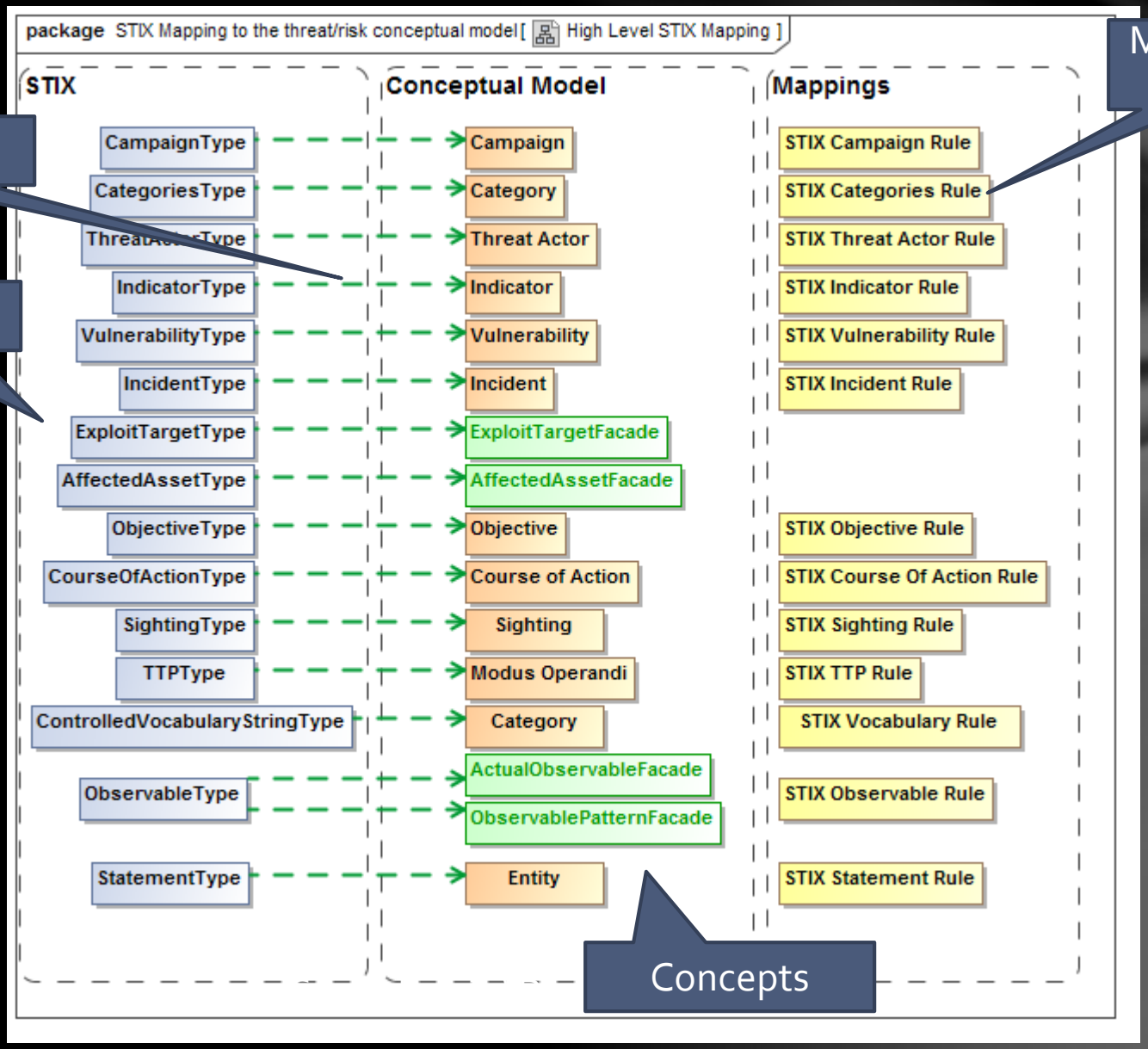
STIX & NIEM

Representing the STIX physical model

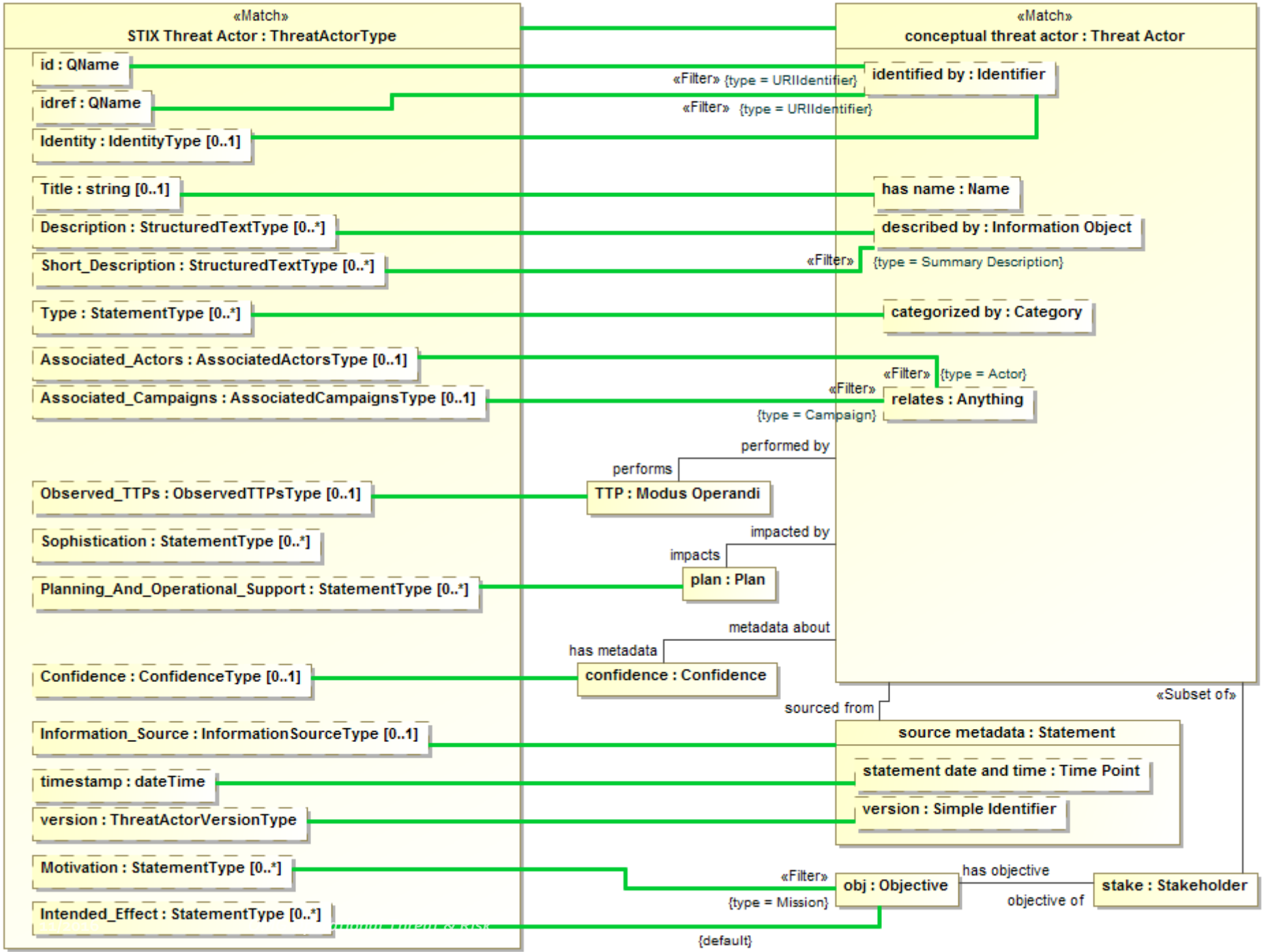
```
se="stixCommon:IndicatorBaseType">
s:sequence>
        <xs:element name="Title" type="xs:string" minC
                <xs:annotation>
                        <xs:documentatior
                </xs:annotation>
        </xs:element>
        <xs:element name="Type" type="stixCommon:C
                <xs:annotation>
                        <xs:documentatior
                        <xs:documentatior
                        <xs:documentatior
                </xs:annotation>
        </xs:element>
        <xs:element name="Alternative_ID" type="xs:st
                <xs:annotation>
                        <xs:documentatior
```

XML Schema is reverse engineered into UML. Next version of STIX will have native UML model.

XML Element represents concept



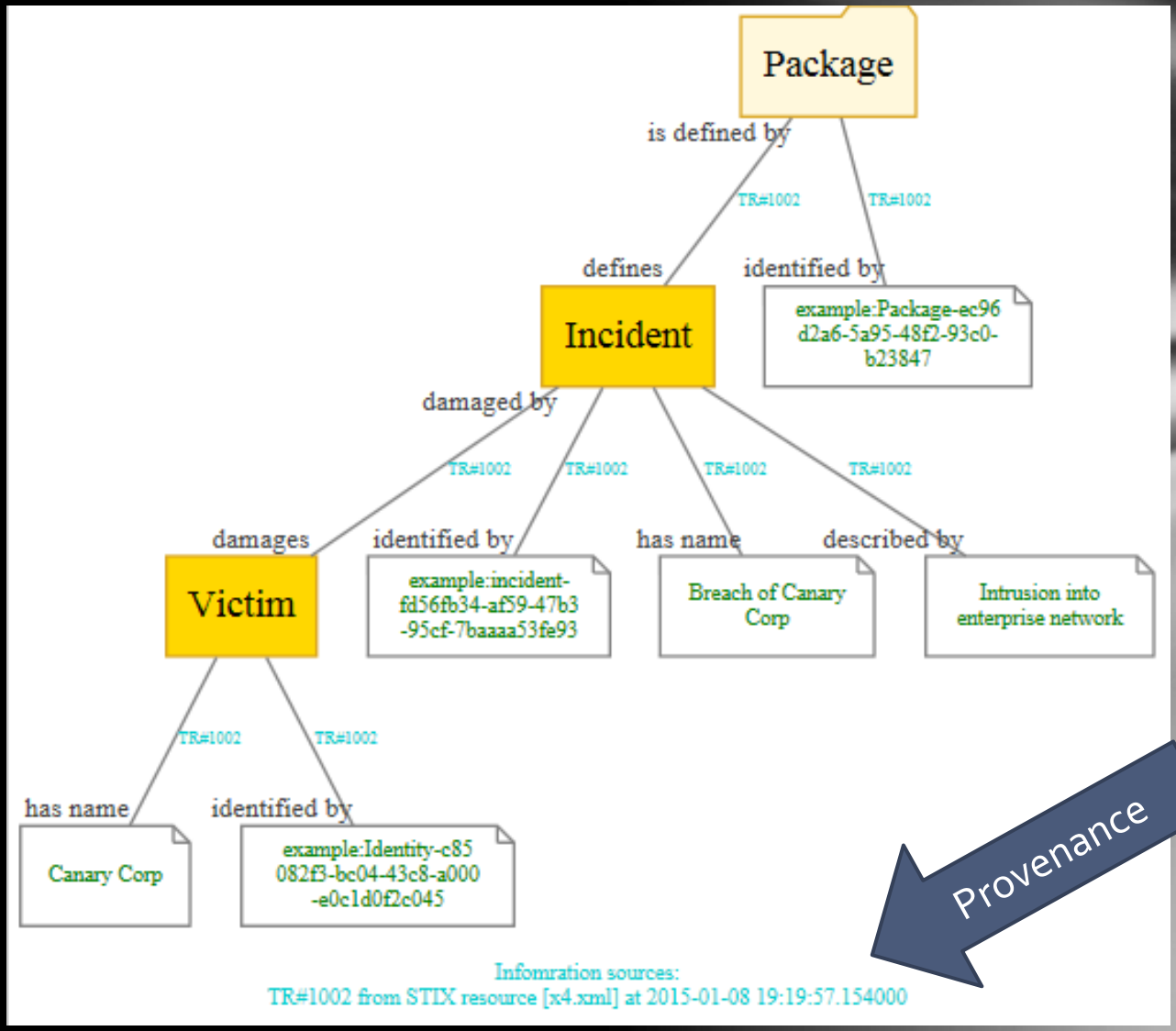
Rules specify mapping details


«Match»
STIX Threat Actor : ThreatActorType
id : QName
idref : QName
Identity : IdentityType [0..1]
Title : string [0..1]
Description : StructuredTextType [0..*]
Short_Description : StructuredTextType [0..*]
Type : StatementType [0..*]
Associated_Actors : AssociatedActorsType [0..1]
Associated_Campaigns : AssociatedCampaignsType [0..1]
Observed_TTPs : ObservedTTPsType [0..1]
Sophistication : StatementType [0..*]
Planning_And_Operational_Support : StatementType [0..*]
Confidence : ConfidenceType [0..1]
Information_Source : InformationSourceType [0..1]
timestamp : dateTime
version : ThreatActorVersionType
Motivation : StatementType [0..*]
Intended_Effect : StatementType [0..*]
«Match»
conceptual threat actor : Threat Actor
«Filter» {type = URIIdentifier}
identified by : Identifier
«Filter» {type = URIIdentifier}
has name : Name
described by : Information Object
«Filter»
{type = Summary Description}
categorized by : Category
«Filter»
{type = Actor}
«Filter»
relates : Anything
{type = Campaign}
performed by
performs
TTP : Modus Operandi
impacted by
impacts
plan : Plan
metadata about
has metadata
confidence : Confidence
«Subset of»
sourced from
source metadata : Statement
statement date and time : Time Point
version : Simple Identifier
«Filter»
{type = Mission}
obj : Objective
has objective
objective of
stake : Stakeholder
{default}

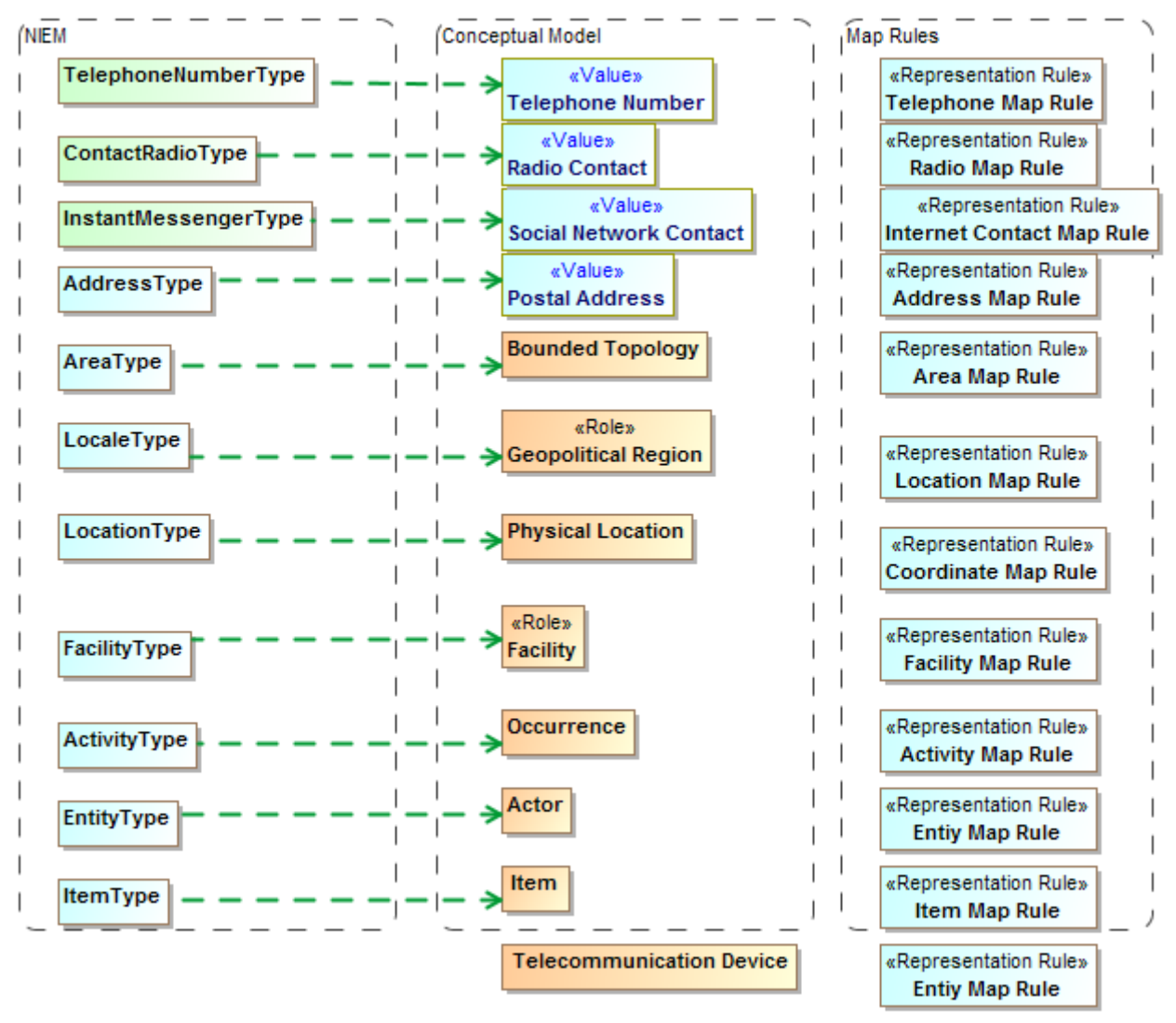
Example STIX source data

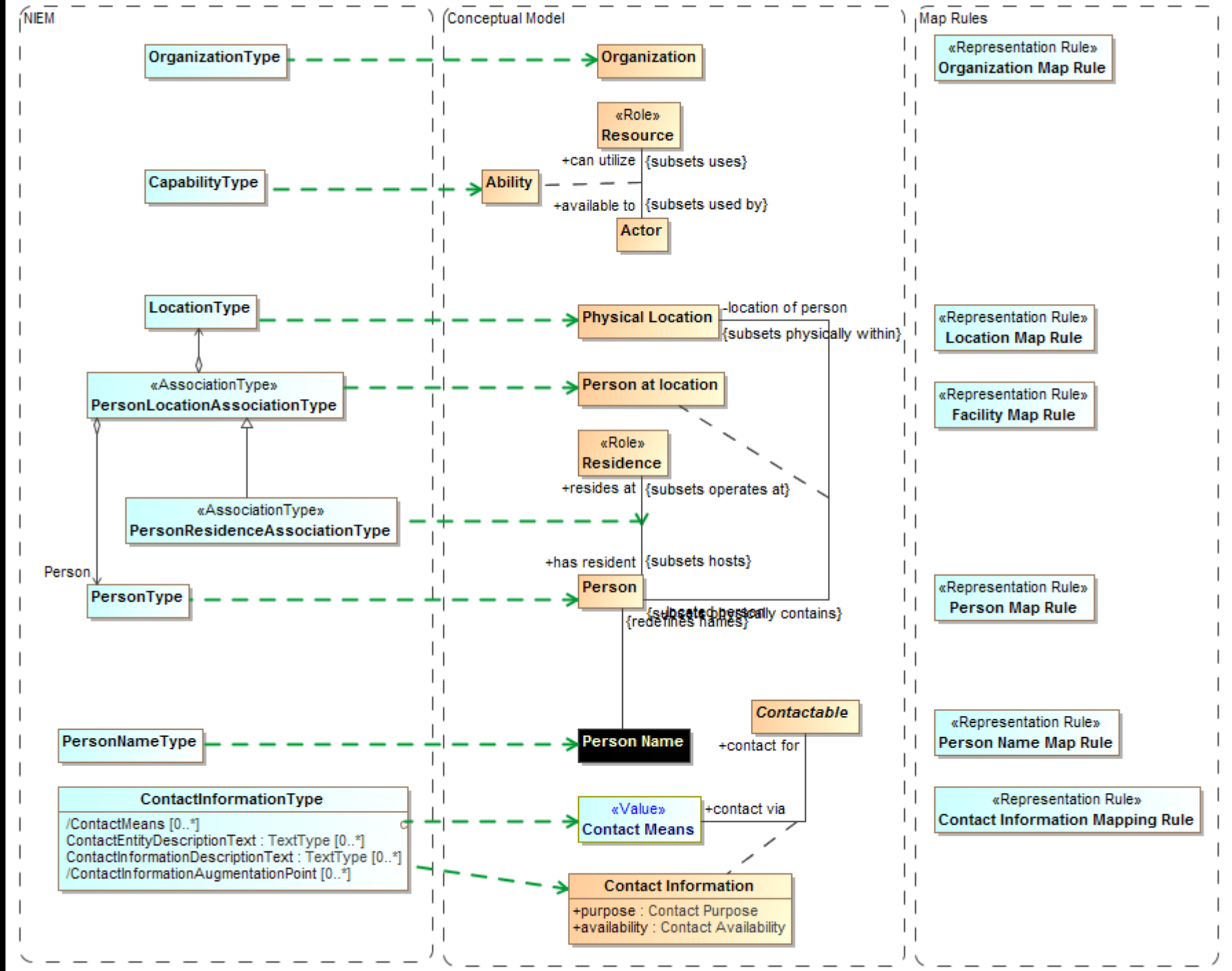
```
<stix:Incident id="example:incident-fd56fb34-af59-47b3-95cf-7baaaa53fe93" timestamp="2014-08-28T16:42:52.859547+00:00"
xsi:type='incident:IncidentType' version="1.1.1">
        <incident:Title>Breach of Canary Corp</incident:Title>
        <incident:Time>
                <incident:Incident_Discovery precision="second">2013-01-13T00:00:00</incident:Incident_Discovery>
        </incident:Time>
        <incident:Description>Intrusion into enterprise network</incident:Description>
        <incident:Reporter>
                <stixCommon:Description>The person who reported it</stixCommon:Description>
                <stixCommon:Identity id="example:Identity-5db269cf-e603-4df9-ae8c-51ff295abfaa">
                        <stixCommon:Name>Sample Investigations, LLC</stixCommon:Name>
                </stixCommon:Identity>
        <stixCommon:Time>
                <cyboxCommon:Produced_Time>2014-03-11T00:00:00</cyboxCommon:Produced_Time>
        </stixCommon:Time>
        </incident:Reporter>
        <incident:Victim id="example:Identity-c85082f3-bc04-43c8-a000-e0c1d0f2c045">
        <stixCommon:Name>Canary Corp</stixCommon:Name>
    </incident:Victim>
        <incident:Impact_Assessment>
        <incident:Effects>
                <incident:Effect xsi:type="stixVocabs:IncidentEffectVocab-1.0">Financial Loss</incident:Effect>
        </incident:Effects>
    </incident:Impact_Assessment>
        <incident:Confidence timestamp="2014-08-28T16:42:52.859570+00:00">
        <stixCommon:Value xsi:type="stixVocabs:HighMediumLowVocab-1.0">High</stixCommon:Value>
    </incident:Confidence>
</stix:Incident>
```

Example of mapped data graph



NIEM Mapping summary (1)




NIEM
Conceptual Model
Map Rules
OrganizationType
Organization
«Representation Rule»
Organization Map Rule
«Role»
Resource
+can utilize
{subsets uses}
CapabilityType
Ability
+available to
{subsets used by}
Actor
LocationType
Physical Location
-location of person
{subsets physically within}
«Representation Rule»
Location Map Rule
«AssociationType»
PersonLocationAssociationType
Person at location
«Representation Rule»
Facility Map Rule
«Role»
Residence
+resides at
{subsets operates at}
«AssociationType»
PersonResidenceAssociationType
+has resident
{subsets hosts}
Person
PersonType
Person
{subsets physically contains}
{redefines names}
«Representation Rule»
Person Map Rule
Contactable
PersonNameType
Person Name
+contact for
«Representation Rule»
Person Name Map Rule
ContactInformationType
/ContactMeans [0..*]
ContactEntityDescriptionText : TextType [0..*]
ContactInformationDescriptionText : TextType [0..*]
/ContactInformationAugmentationPoint [0..*]
«Value»
Contact Means
+contact via
«Representation Rule»
Contact Information Mapping Rule
Contact Information
+purpose : Contact Purpose
+availability : Contact Availability

Result of mapping

Two-way semantic "pivot" through conceptual reference models

The Process

Building a community and standards to protect against threats and risks

Open Community Process

Our goal is to create and encourage

- Open standards for threat and risk information sharing
- A community of information providers, consumers, analysts and products

- The standards process is organized under the "Object Management Group" (www.omg.org)
- The community "home" is www.threatrisk.org

While not required by OMG process, the submission team publishes draft specifications to invite comment, engagement, community building and implementation. OMG Membership is encouraged but not required.

Stakeholders may contribute to the specification.

We are also exploring options for open source implementations

Who Is OMG?

Object Management Group (OMG):

- Founded in 1989
- More than 470 member companies
- The largest and longest standing not-for-profit, open-membership consortium which develops and maintains computer industry specifications.
- Continuously evolving to remain current while retaining a position of thought leadership.

Developing Standards

Standards are developed using OMG's mature, worldwide, open development process. With over 20 years of standards work, OMG's one-organization, one-vote policy ensures that every vendor and end-user, large and small, has an effective voice in the process.

Finance Healthcare Insurance Government







OMG's Best-Known Successes

Common Object Request Broker Architecture

- CORBA® remains the only language- and platform-neutral interoperability standard

Unified Modeling Language

- UML® remains the world's only standardized modeling language

Business Process Modeling Notation

- BPMN™ provides businesses with the capability of understanding their internal business procedures

Common Warehouse Metamodel

- CWM™, the integration of the last two data warehousing initiatives

Meta-Object Facility

- MOF™, the repository standard

XML Metadata Interchange

- XMI®, the XML-UML standard

Submitters and Contributors (Thus Far)

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KDM Analytics, Inc.

International Business Machines, Inc.

RSA, The Security Division of EMC

Lockheed Martin, Inc.

Oracle Corporation

Fujitsu

Information Sharing Environment (ise.gov)

Demandware

U.S. Air force

U.S. Defense Security Services

California Public Safety (http://www.Caloes.ca.gov)

U.S. National Information Sharing Model PMO (https://www.niem.gov/)

Duke Energy

NSA/UCDMO

NIST

INCOSE

Integrated Networking Technologies, Inc.

Tibco Software Inc.

Hitachi

NC4

Others pending approval

Questions and Invitation

Join us! Help us: Define the standard, validate it with your use cases, merge with other models, implement it, fund it