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NIEM and Ontologies

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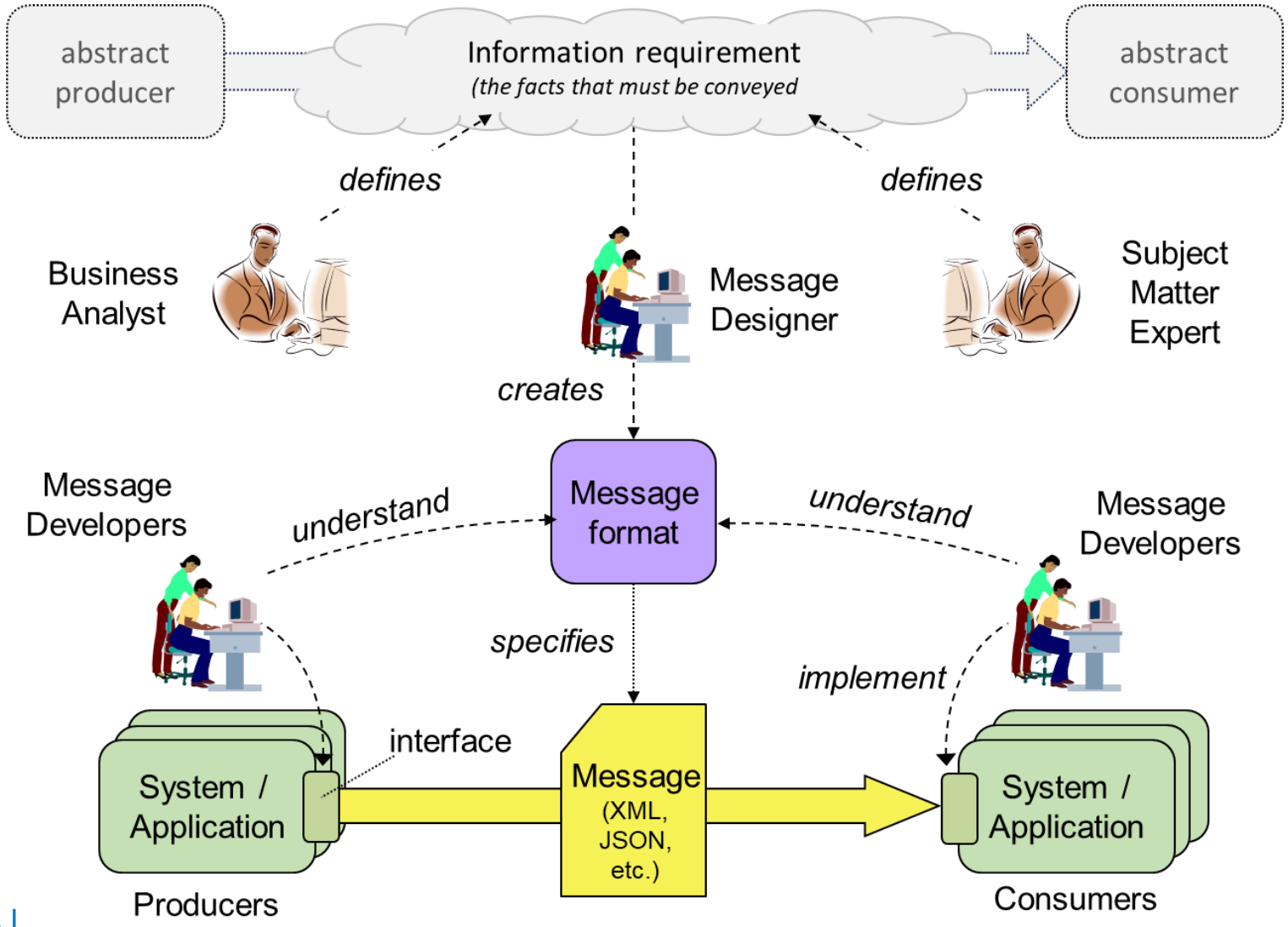
presented at the DIOWG Summit
8 May 2024

NIEM-BASED DATA EXCHANGE



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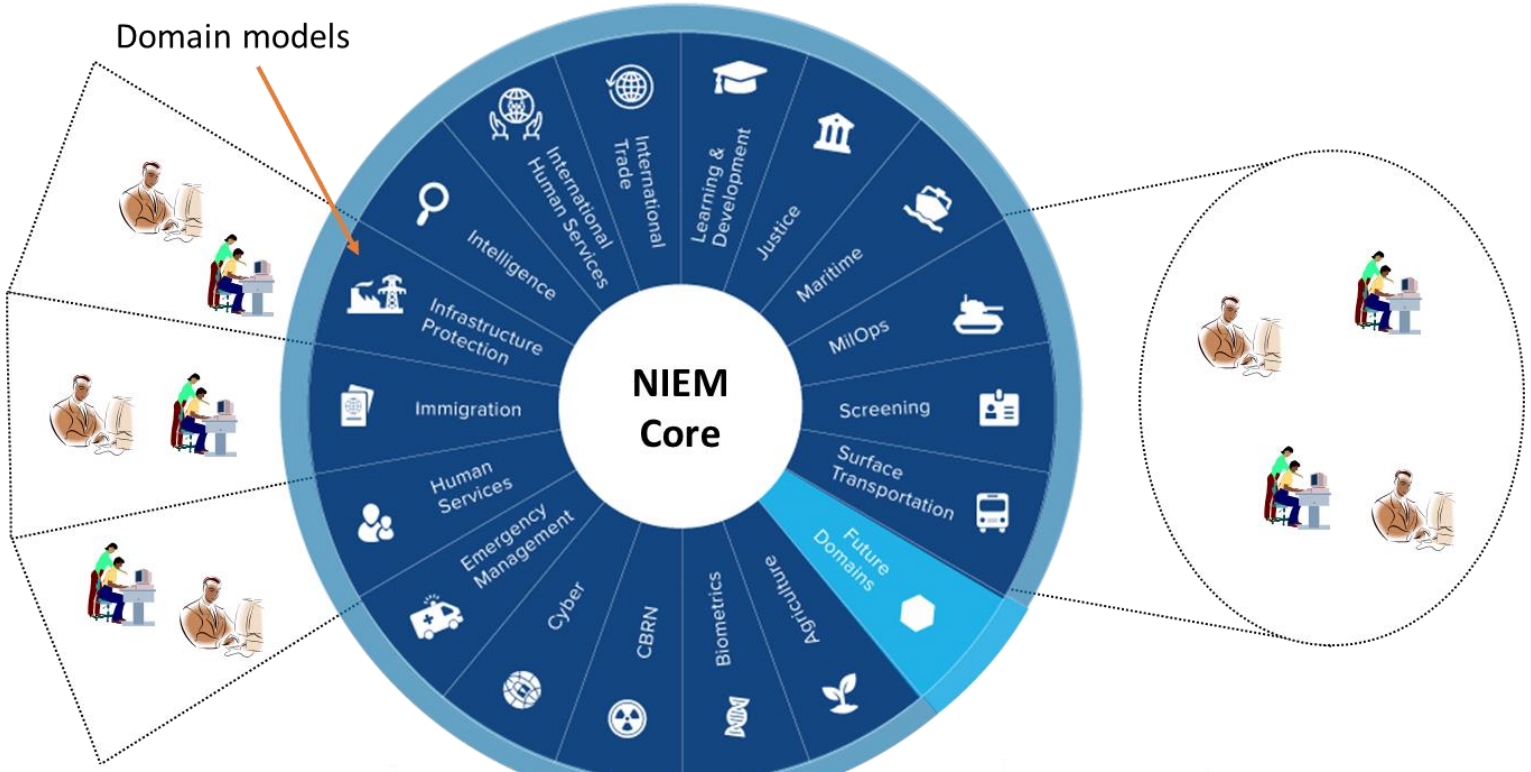
ROLES IN NIEM MODEL DESIGN



Domain communities: analysts, SMEs, developers with shared subject interests

NIEM data model

Business architecture committee (NBAC): representatives from all communities, looking for commonalities

design

design

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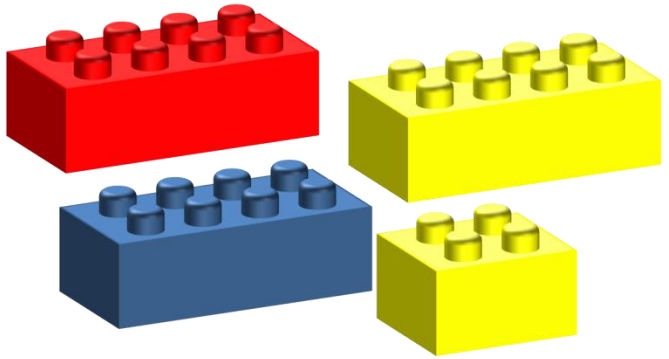
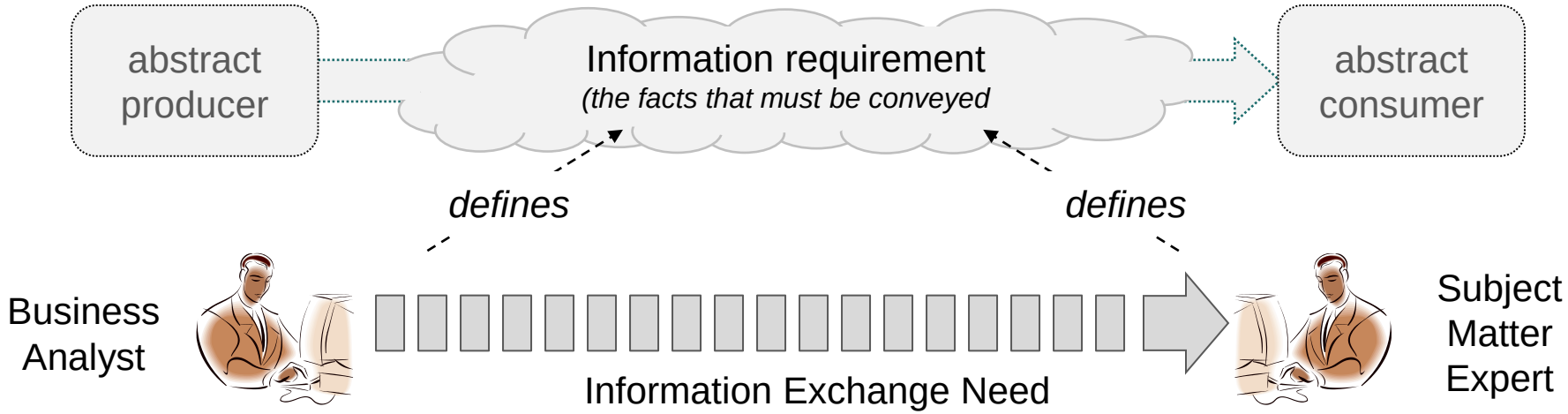
“LEGO™ BLOCK” MODELING

- **Designing an information exchange with NIEM is like building a plastic model out of Lego blocks**
  - You decide what the model should look like
  - You choose the blocks you need for your model
  - Technical specification ensures that the blocks will snap together
- **NIEM is even better than Legos, because**
  - Each NIEM domain provides a collection of useful blocks
  - You can easily create any block that’s missing from your set (and then share it with others)
  - The blocks are all free



DESIGNING A MESSAGE FORMAT

Start with an information exchange need. You don't have to know all of the participants in advance. It's enough to know that a producer has data that needs to be shared with someone



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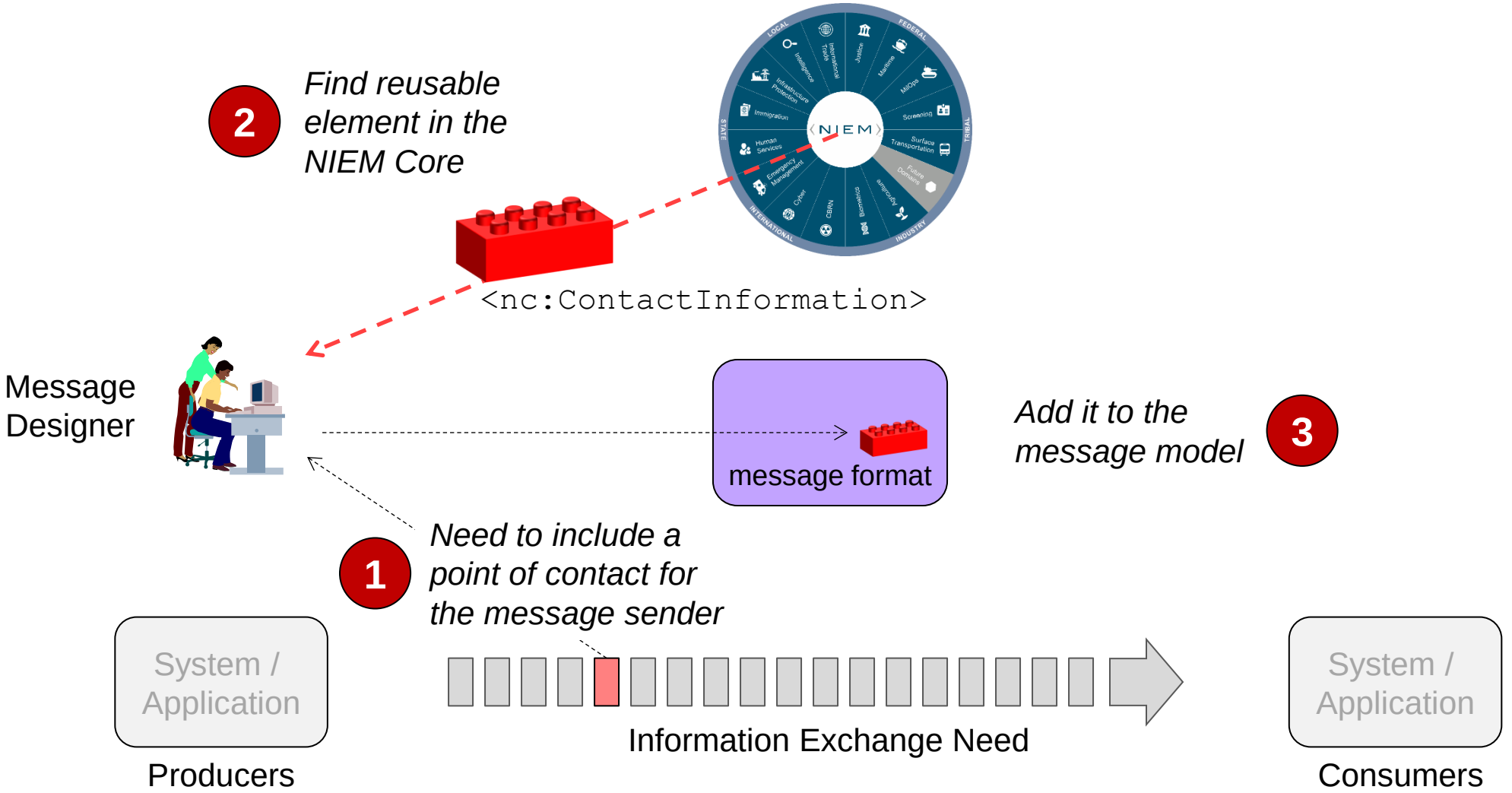
REUSE CORE COMPONENTS FOR DATA NEEDS



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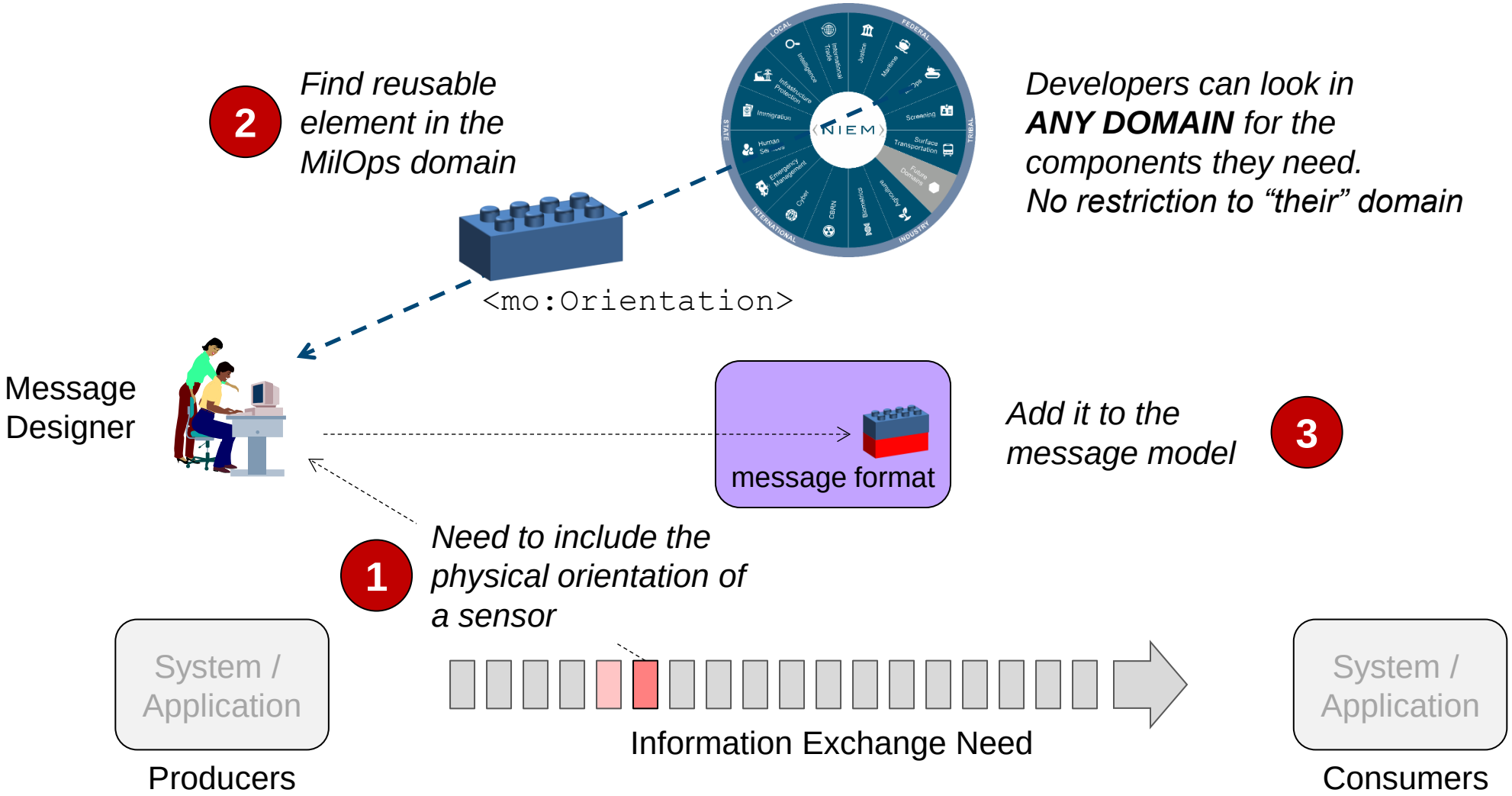
REUSE DOMAIN COMPONENTS FOR DATA NEEDS



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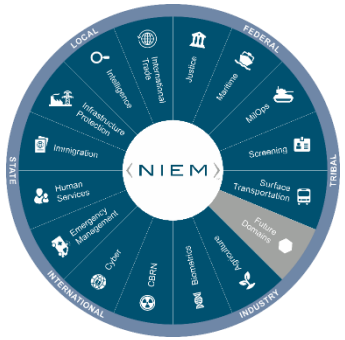
CREATE NEW COMPONENTS FOR DATA NEEDS

2

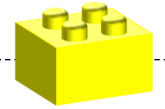
Can't find a matching component in core or domains

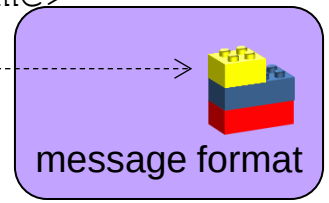


*Developers can create **ANY COMPONENT** they need for their exchange. No restriction to what's already in the NIEM model.*

Message Designer

`<cot:SensorModelName>`





Create and add a new component to the message model

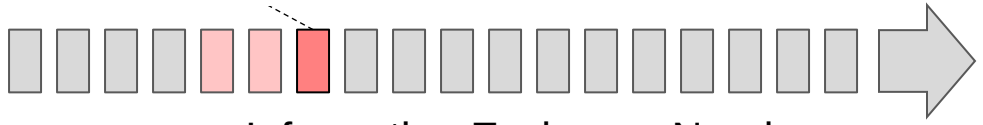
3

1

Need to include the model name of the reporting sensor

System / Application

Producers



Information Exchange Need

System / Application

Consumers

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A COMPLETED EXCHANGE SPECIFICATION

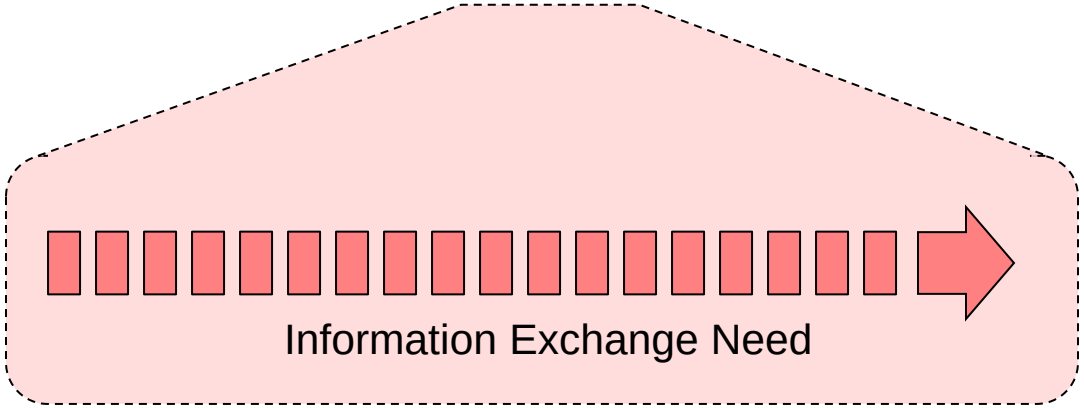
The message format is done when it includes a representation for all aspects of the exchange need

Message Designer

message format

System / Application

Producers



System / Application

Consumers

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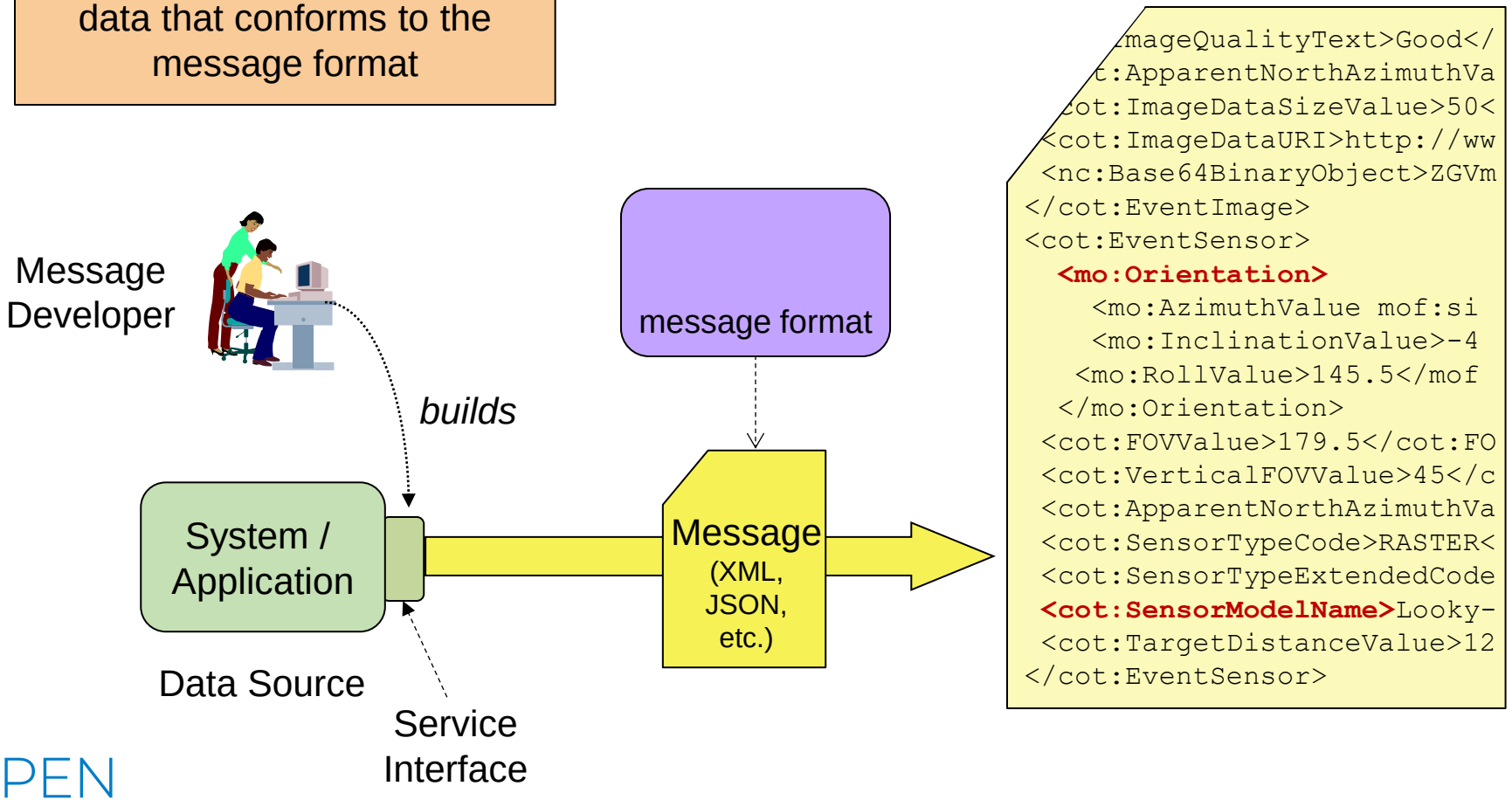
PRODUCER'S SERVICE INTERFACE

Developers write **code to export the source's data**, in the form of XML or JSON data that conforms to the message format



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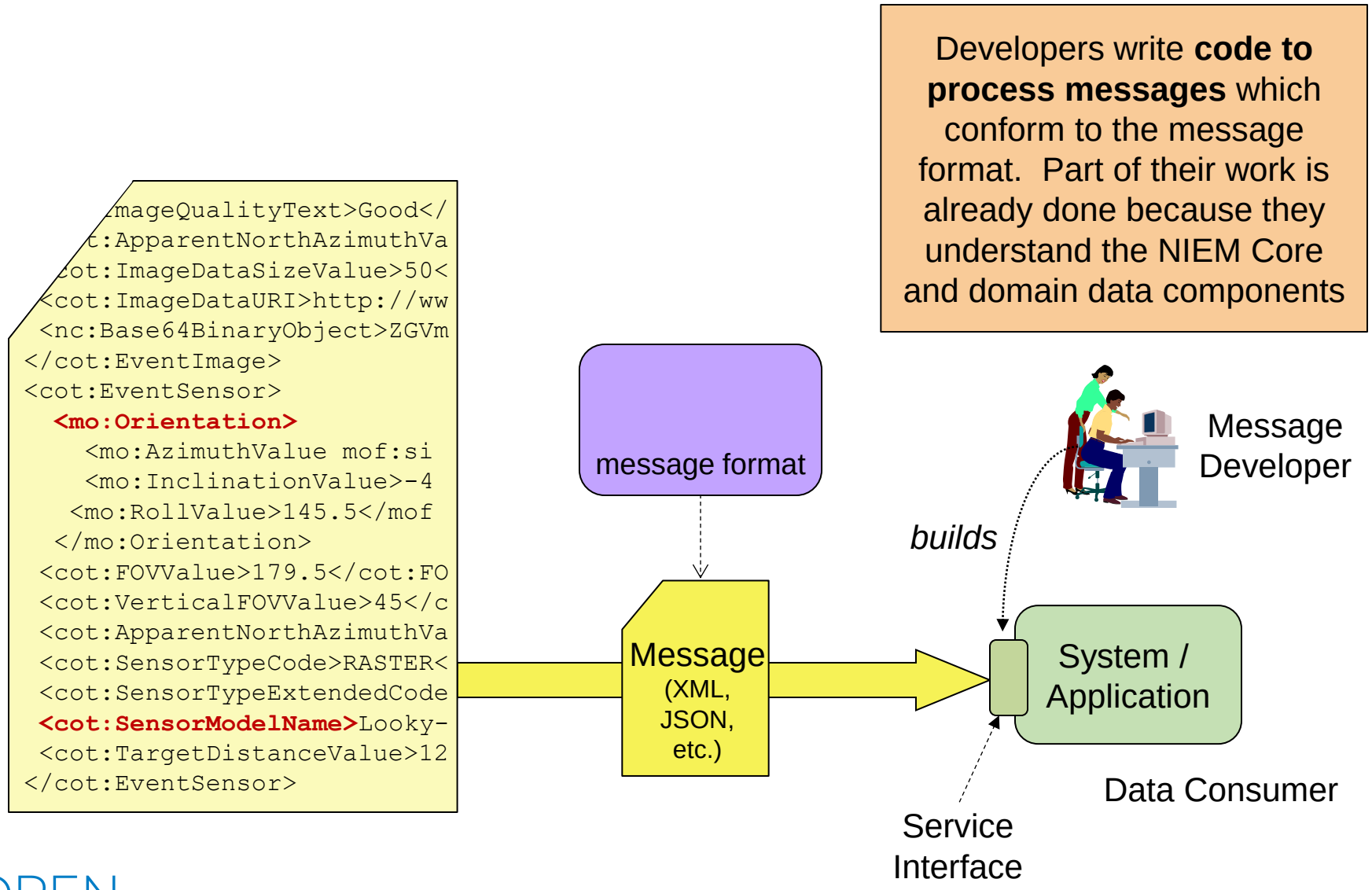
CONSUMER'S SERVICE INTERFACE



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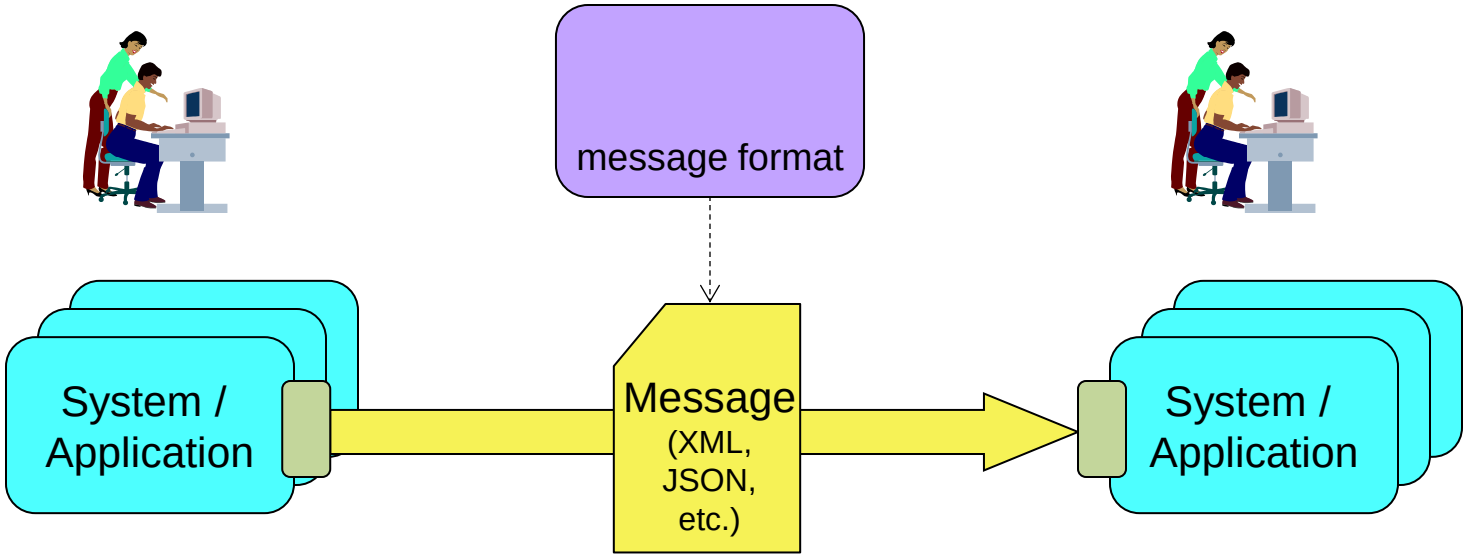
IMPLEMENTING THE EXCHANGE SPECIFICATION

Other producers and consumers may join at any time, in any order, by implementing the message format.

By following the NIEM standards-based approach, machine-to-machine data exchanges can be implemented in less time and at lower cost for the enterprise as a whole



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NIEM MESSAGE DATA IN RDF

- **NIEM messages can be converted into RDF**
  - The NTAC is providing free and open-source tools for these conversions

```
<ex:CrashDriverInfo>
 <j:Crash>
  <j:CrashVehicle>
   <j:CrashDriver>
    <nc:Person s:id="P1">
     <nc:PersonBirthDate>
      <nc:Date>1890-05-04</nc:Date>
     </nc:PersonBirthDate>
     <nc:PersonName>
      <nc:PersonGivenName>Peter</nc:PersonGiv
      <nc:PersonMiddleName>Death</nc:PersonMi
```

```
_:n0 a j:CrashType ;
     j:CrashVehicle _:n1 .
_:n1 a j:CrashVehicleType ;
     j:CrashDriver _:n2 .
_:n2 a j:CrashDriverType ;
     nc:Person _:P1 ;
_:P1 a nc:PersonType ;
     nc:PersonBirthDate _:n3 ;
     nc:PersonName _:n4 .
_:n3 a nc:DateType ;
     nc:Date "1890-05-04" .
```

NIEM-based message in XML ⟵ *equivalent to* ⟶ NIEM-based message in RDF

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NIEM MODELS IN RDF

- **NIEM models can be converted into RDF**
  - The NTAC is providing free and open-source tools for these conversions

```
<xs:complexType name="PersonType">
 <xs:annotation>
  <xs:documentation>A data type for a human being.<
 </xs:annotation>
 <xs:complexContent>
  <xs:extension base="structures:ObjectType">
   <xs:sequence>
    <xs:element ref="nc:PersonBirthDate"/>
    <xs:element ref="nc:PersonName"/>
   </xs:sequence>
  </xs:extension>
 </xs:complexContent>
</xs:complexType>
```

```
nc:PersonType
 a owl:Class ;
 rdfs:comment "A data type for a human being." .

nc:PersonName
 a owl:ObjectProperty ;
 rdfs:domain nc:PersonType ;
 rdfs:range nc:PersonNameType ;
 rdfs:comment "A combination of names and/or
titles by which a person is known." .

nc:PersonBirthDate
    a owl:ObjectProperty ;
```

NIEM model in XSD ⟵ *equivalent to* ⟶ NIEM model in RDF

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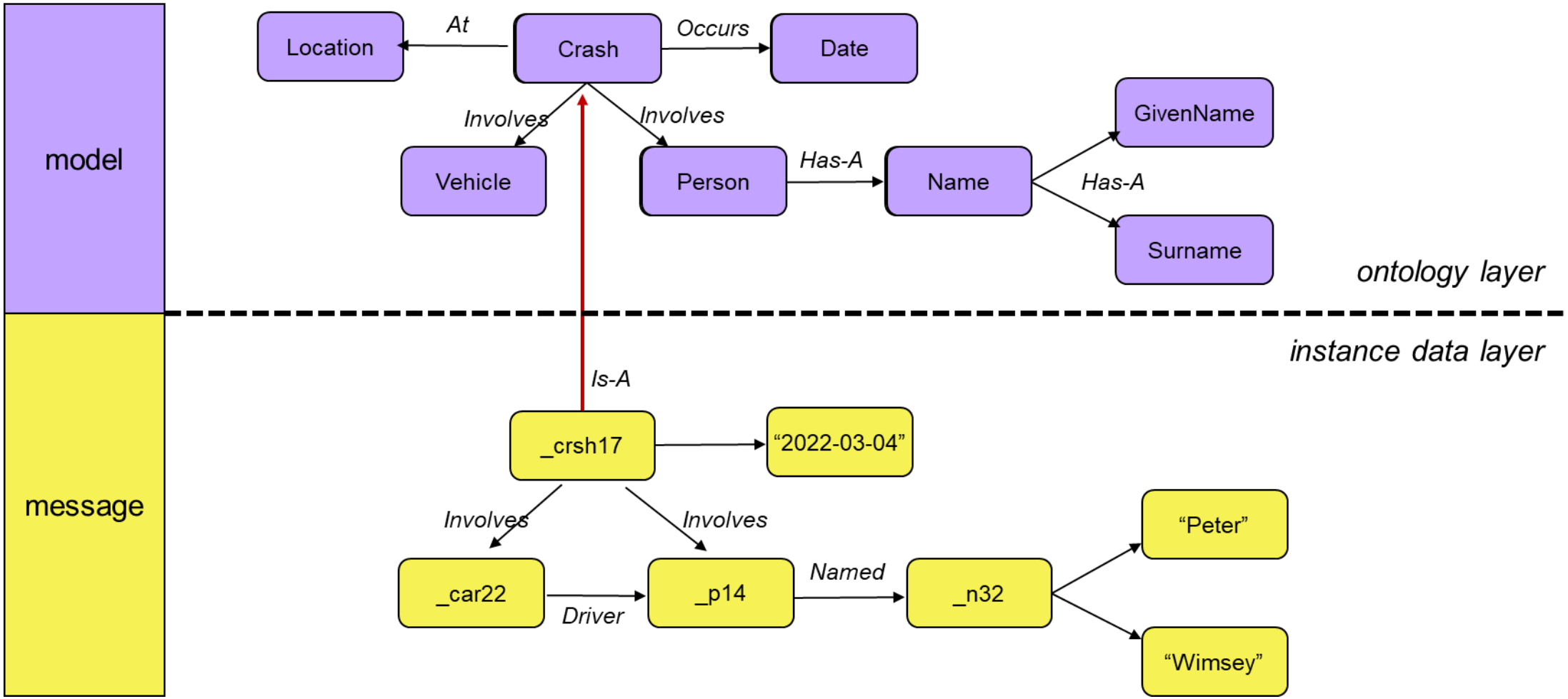
MODEL + MESSAGE = KNOWLEDGE GRAPH



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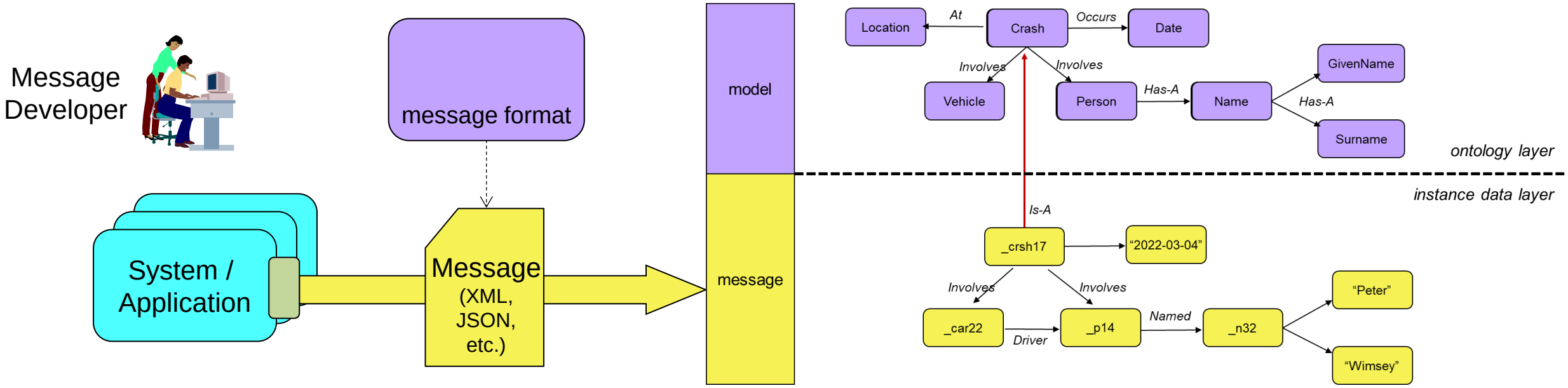
NIEM DATA AS A KNOWLEDGE GRAPH



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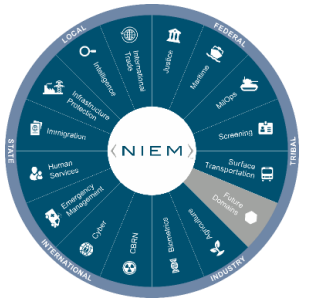
MODEL + MESSAGE = KNOWLEDGE GRAPH

- **Data from systems that generate NIEM-based messages is available as a knowledge graph**
  - With no extra effort from the developers of those systems
- **If the NIEM model becomes aligned with useful upper ontologies, then NIEM message models and instance data will also be aligned**
- **This could reduce your data wrangling workload even more**



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RELATING A NIEM MODEL TO CCO

- Relationships to upper / middle ontologies can be added now
- Over time, the NIEM model could change to align with ontologies

```
<xs:complexType name="PersonType">
 <xs:annotation>
  <xs:documentation>A data type for a human being.<
 </xs:annotation>
 <xs:complexContent>
  <xs:extension base="structures:ObjectType">
   <xs:sequence>
    <xs:element ref="nc:PersonBirthDate"/>
    <xs:element ref="nc:PersonName"/>
   </xs:sequence>
  </xs:extension>
 </xs:complexContent>
</xs:complexType>
```

```
nc:PersonType
 a owl:Class ;
 rdfs:comment "A data type for a human being." .

nc:PersonName
 a owl:ObjectProperty ;
 rdfs:domain nc:PersonType ;
 rdfs:range nc:PersonNameType ;
 rdfs:comment "A combination of names and/or
titles by which a person is known." .

nc:PersonType rdfs:subclassOf cco:Person .
```

NIEM model in XSD ⟵ *equivalent to* ⟶ NIEM model in RDF

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A CO-OPERATOR, NOT A COMPETITOR

A new slide, based on questions at the summit

- **Are you an ontologist?**
  - We aren't trying to get *you* to use NIEM
  - We aren't trying to replace what you are doing
- **There are many source systems exposing data through an API, today and tomorrow**
  - We want them to use NIEM
  - Then they will reuse community definitions, instead of inventing everything from scratch
  - And their data will be available as a knowledge graph
- **We want you to help us do that better**
  - So that their data will be more useful to you
  - So that we can help them reuse the knowledge in your ontologies

NIEM AND ONTOLOGIES: THE FUTURE

- **NIEM is an ontology player, not a competitor**
  - Designing data contracts means NIEM will always be a little different, but...
  - Will gradually converge, as NIEM shifts from its XSD beginning to its RDF foundations
- **Already seeing some exciting applications:**
  Sonoma County CA criminal justice
  - Multiple sources reconciled through a NIEM model
  - Data from sources converted to RDF in a COTS triple store
  - LLM uses NIEM model to generate SPARQL query explanations
- **Many sources will be available as knowledge graphs**
  - NIEM as an "ontology on-ramp" – will reduce data wrangling effort
- **Next step: Explore alignment with BFO/CCO**
  - Small-scale experiment to demonstrate value

Dr. Scott's Crystal Ball

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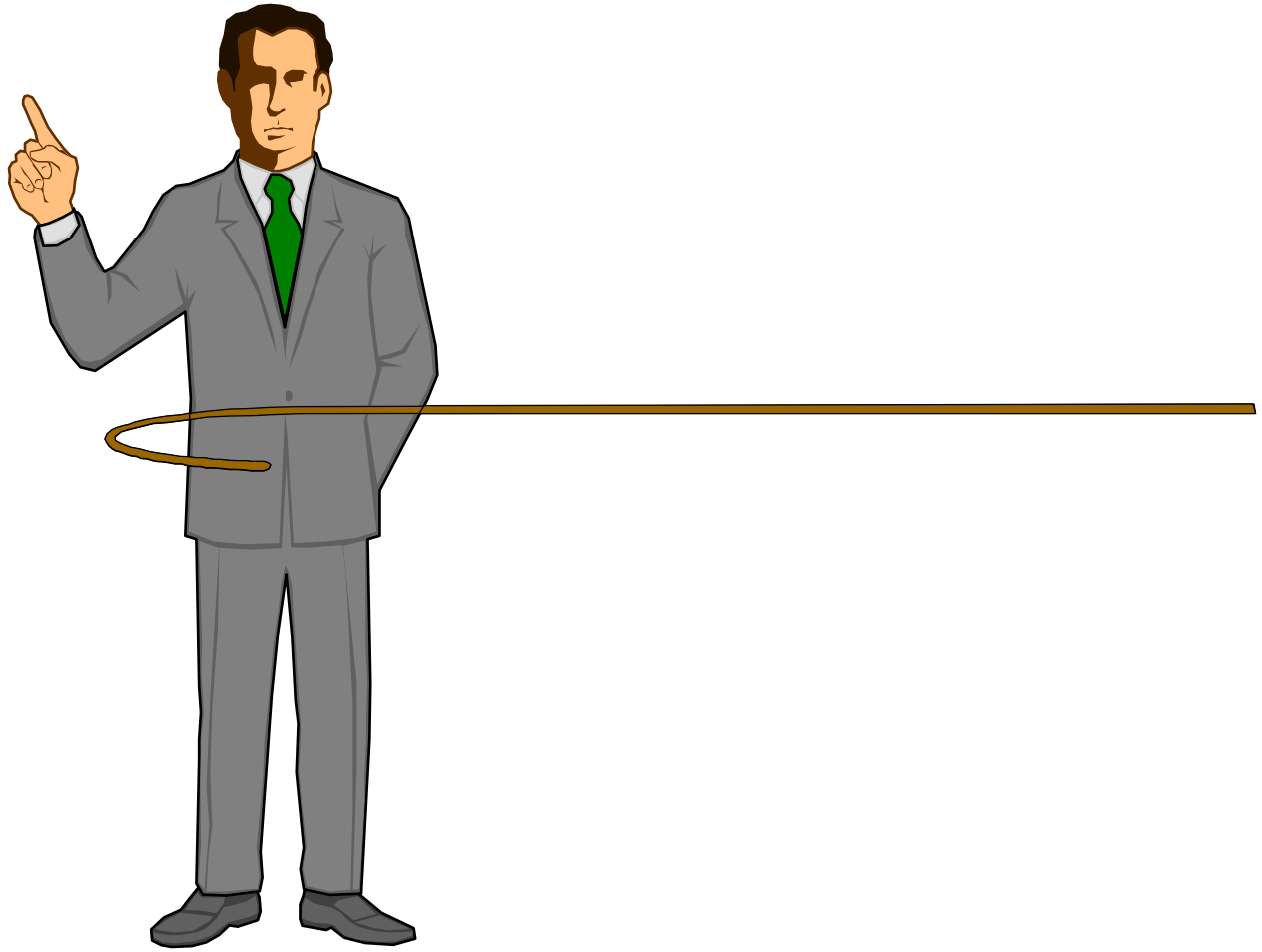
SUMMARY



SUMMARY

- **NIEM is a framework for designing machine-to-machine data exchange specifications**
  - A technical architecture for message models and runtime messages
  - A library of community-agreed data definitions: the NIEM Model
- **Many NIEM-based data exchanges in operation today**
- **In NIEM 6.0, models and messages can be converted to RDF**
  - With no extra effort from message designers and developers
  - The result is a knowledge graph (at least in form)
  - Could provide data for inferencning and SPARQL queries w/o much data wrangling; however...
- **The NIEM model today is a sparse ontology**
  - No relations to any upper ontology at present
  - Adding those relations will take some work
  - Need a demonstration project to show the value

RESOURCES

- **NIEM Technical Architecture Committee**
  - Co-chair: Scott Renner, sar@mitre.org
  - Github: github.com/niemopen/ntac-admin
- **NIEMOpen Managing Director:** Katherine Escobar, katherine.b.escobar.civ@mail.mil
- **Useful documents, specifications, tools**
  - *Understanding the NIEM Technical Architecture*
    https://github.com/niemopen/ntac-admin/tree/main/project-notes
  - *NIEM 6.0 Naming and Design Rules*
    https://github.com/niemopen/niem-naming-design-rules/tree/dev
  - *NIEM Common Model Format (CMF) specification*
    https://github.com/niemopen/common-model-format
  - *Common Model Format Tool (CMFTool)*
    https://github.com/niemopen/cmftool