STIX & TAXII

Analyzing and Sharing Cyber Threat Intelligence

What are STIX and TAXII?

A language for modeling and representing cyber threat intelligence.

A protocol for exchanging cyber threat intelligence.

STIX and TAXII are International Standards

- **STIX and TAXII were developed by DHS and MITRE in conjunction with major collaboration partners from:**
  - US Government
  - Financial Sector
  - Critical Infrastructure Sector
  - International industry and government

- **As of 2015, both have transitioned to OASIS in the newly formed Cyber Threat Intelligence Technical Committee**

OASIS
Advancing open standards for the information society

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Structured Threat Information Expression

A language for modeling and representing cyber threat intelligence.

- Structured language for automation
- Designed for sharing and analysis
- Active community of developers and analysts
- International standard in OASIS

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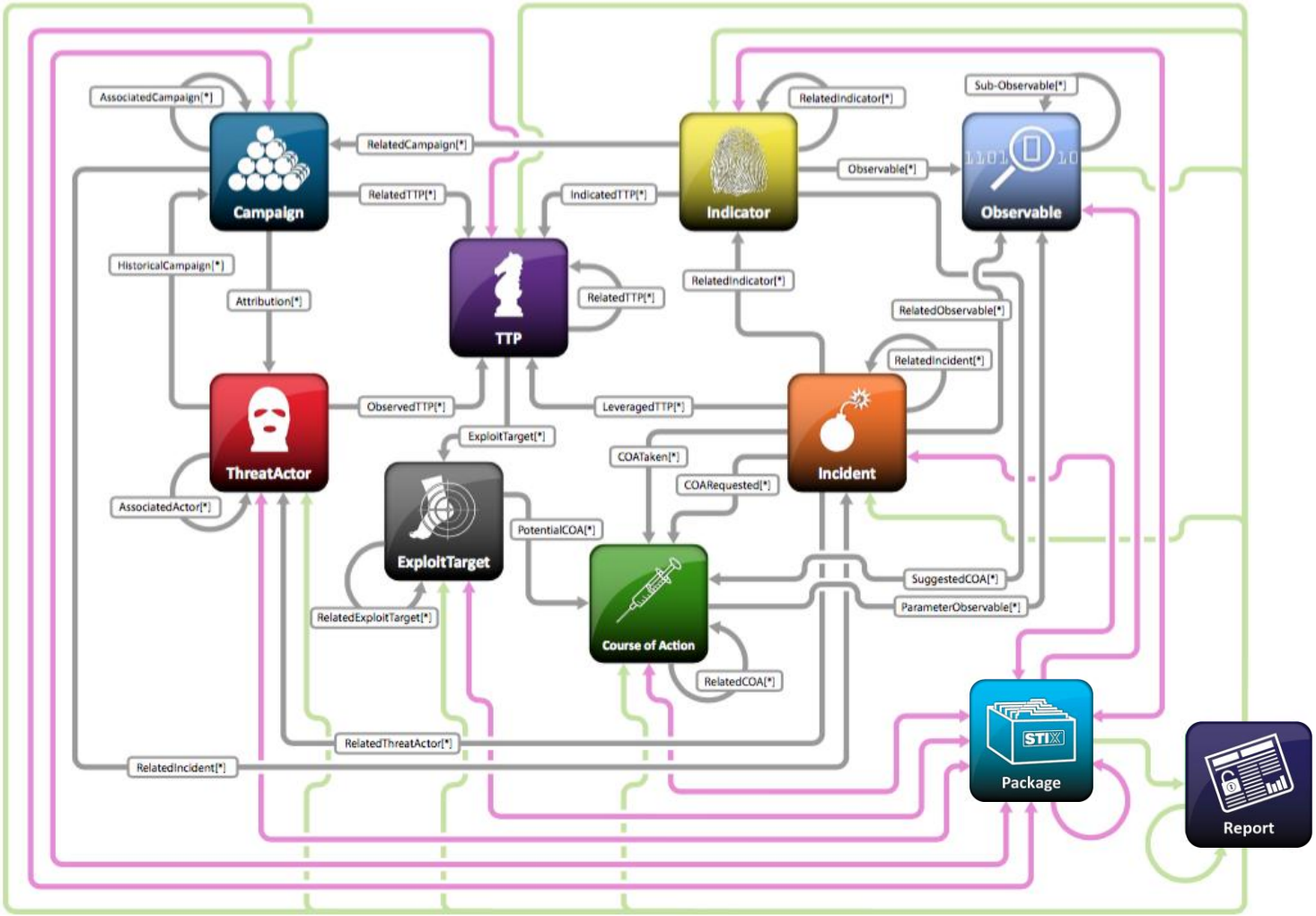
Current Status

- **STIX 1.2 is the latest published version**
  - Published by DHS/MITRE
  - XML Schemas
- **STIX 1.2.1 will be published by OASIS**
  - Nearly identical to STIX 1.2
  - Will include text specifications, UML, and XML schemas
- **STIX 2.0 is currently in development**
  - JSON-based
  - Published by OASIS
  - Will include more comprehensive text specifications and UML

STIX 1.2 Architecture



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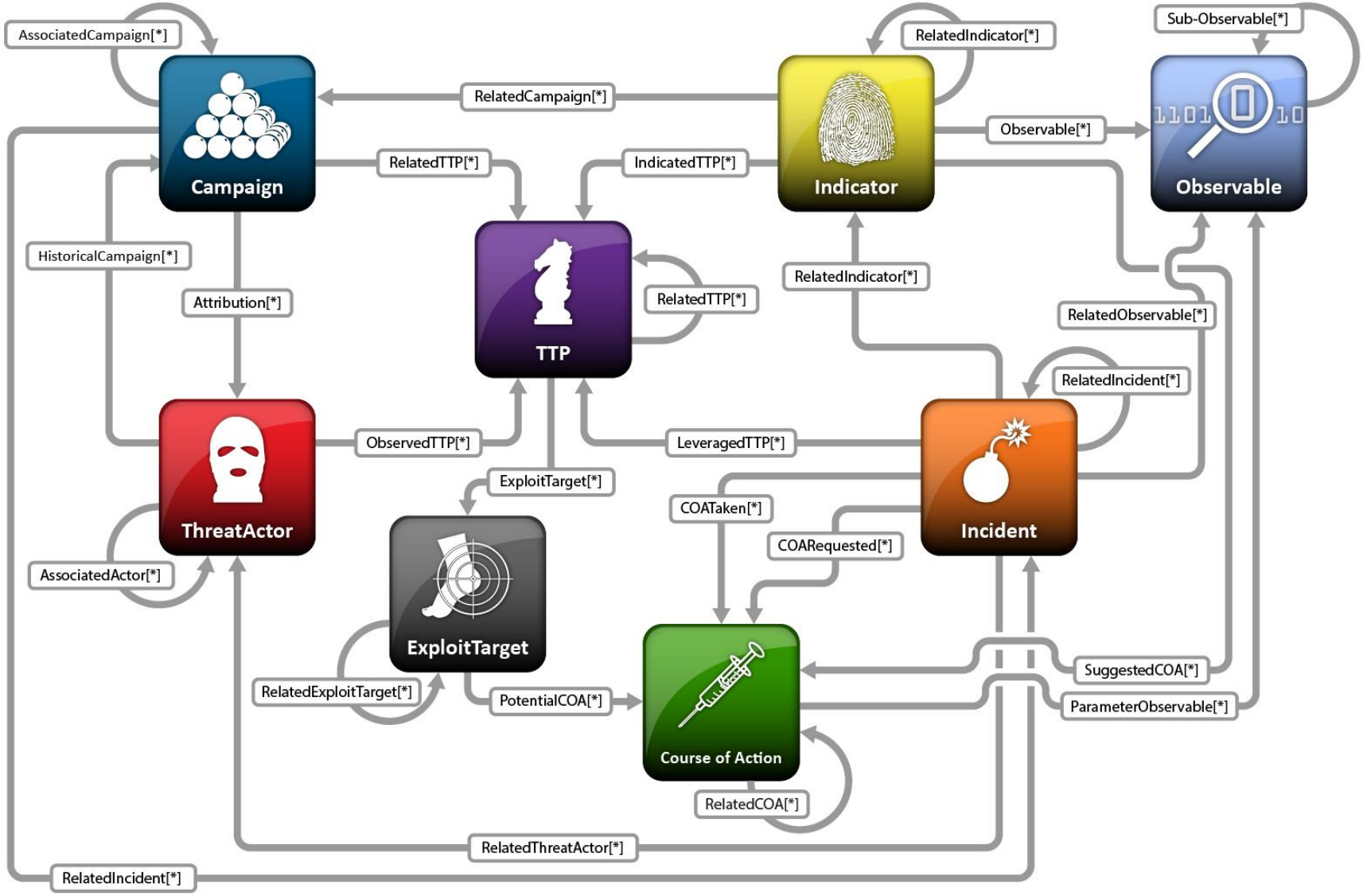
STIX 1.2 Architecture - ZOOM



Observable

Instances of **events and objects** that **have been seen** in cyberspace
(and)
Patterns for **events and objects** that **might be seen** in cyberspace

Observable

- 90+ Object Types
  - Files (names, hashes, …)
  - Addresses (IP, e-mail, domains, …)
  - E-mails (subject, sender, attachments, ...)
  - Registry Keys
- Patterning support
  - Wildcards
  - Compositional logic
- Events (e.g. File A downloads File B)

Examples

IP	192.168.1.4
Hash	d99a74fbe169e3eba0…
Traffic	192.168.1.4 -> 10.10.1.1

Filename Pattern	File/File_Name [Contains] bad.exe
Email Regex	Email/Subject [Matches] BAD.+STUFF

XML

IP Address:

```
<cybox:Observable id="example:observable-c8c32b6e-2ea8-51c4-6446-7f5218072f27">
    <cybox:Object id="example:object-d7fcce87-0e98-4537-81bf-1e7ca9ad3734">
        <cybox:Properties xsi:type="AddressObject:AddressObjectType" category="ipv4-addr">
            <AddressObject:Address_Value>198.51.100.2</AddressObject:Address_Value>
        </cybox:Properties>
    </cybox:Object>
</cybox:Observable>
```

Email Subject Pattern:

```
<indicator:Observable id="example:Observable-e9926796-6b52-463c-8be1-0ab66e9adb1c">
    <cybox:Object id="example:EmailMessage-38afa5c9-ef26-4948-928b-0230521c67b7">
        <cybox:Properties xsi:type="EmailMessageObj:EmailMessageObjectType">
            <EmailMessageObj:Header>
                <EmailMessageObj:Subject
                  condition="StartsWith">[IMPORTANT] Please Review Before</EmailMessageObj:Subject>
            </EmailMessageObj:Header>
        </cybox:Properties>
    </cybox:Object>
</indicator:Observable>
```

Indicator

Pattern* for **something you might see**
and
what it means if you see it

- *Patterns* are represented using CybOX
- *What it means* is represented via a TTP or Campaign
- Also includes context, such as potential courses of action, timeframes, and likely impact

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Examples

C2	1.2.3.x = C2 for Actor Z
Malware	h99a74… = PIVY v423
Phishing	E-mail from x@x = phishing

XML

```
<stix:Indicators>
    <stix:Indicator id="example:indicator-a932fcc6-e032-176c-126f-cb970a5a1ade" xsi:type='indicator:IndicatorType'
    timestamp="2014-05-08T09:00:00.000000Z">
        <indicator:Title>File hash for Poison Ivy variant</indicator:Title>
        <indicator:Type xsi:type="stixVocabs:IndicatorTypeVocab-1.0">File Hash Watchlist</indicator:Type>
        <indicator:Observable id="example:Observable-7d6f87bb-b4cd-42dd-b655-72557e9ea79f">
            <cybox:Object id="example:File-91040dc2-28d8-4925-bfe8-6b50d300afe1">
                <cybox:Properties xsi:type="FileObj:FileObjectType">
                    <FileObj:Hashes>
                        <cyboxCommon:Hash>
                            <cyboxCommon:Type xsi:type="cyboxVocabs:HashNameVocab-1.0">SHA256</cyboxCommon:Type>
                            <cyboxCommon:Simple_Hash_Value condition="Equals">ef537f25...</cyboxCommon:Simple_Hash_Value>
                        </cyboxCommon:Hash>
                    </FileObj:Hashes>
                </cybox:Properties>
            </cybox:Object>
        </indicator:Observable>
        <indicator:Indicated_TTP>
            <stixCommon:TTP idref="example:ttp-e610a4f1-9676-eab3-bcc6-b2768d58281a" />
        </indicator:Indicated_TTP>
    </stix:Indicator>
</stix:Indicators>
```

Incident

Information about a cybersecurity **investigation** or **incident.**

- Victim identity
- Impacted assets and business functions
- Attribution to a threat actor or campaign
- Leveraged TTPs (malware, attack patterns, etc)
- Indicators that detected it
- Exploit targets that were used to gain entry
- Times and actions

Examples

Basic	System XYZ has PIVY
APT	Systems 3,4,7 owned by ACME, Inc. have malware. APT31 is suspected.

XML

```
<stix:Incident id="example:incident-8236b4a2-abe0-4b56-9347-288005c4bb92" timestamp="2014-11-18T23:40:08.061362+00:00"
xsi:type='incident:IncidentType' version="1.2">
    <incident:Title>Breach of Cyber Tech Dynamics</incident:Title>
    <incident:Time>
        <incident:Initial_Compromise precision="second">2012-01-30T00:00:00</incident:Initial_Compromise>
        <incident:Incident_Discovery precision="second">2012-05-10T00:00:00</incident:Incident_Discovery>
        <incident:Restoration_Achieved precision="second">2012-08-10T00:00:00</incident:Restoration_Achieved>
        <incident:Incident_Reported precision="second">2012-12-10T00:00:00</incident:Incident_Reported>
    </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-cd64aaa6-b1c0-4026-8ea1-14ff5a19e5fb">
            <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-dd8637b7-51b4-48f0-9e3c-a2b23b3a2dd7">
        <stixCommon:Name>Cyber Tech Dynamics</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="2014-11-18T23:40:08.061379+00:00">
        <stixCommon:Value xsi:type="stixVocabs:HighMediumLowVocab-1.0">High</stixCommon:Value>
    </incident:Confidence>
</stix:Incident>
```

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Tactics, Techniques, and Procedures (TTP)

HSSEDI™

Adversary behavior and resources, including **malware**, **attack patterns**, **exploits**, **infrastructure**, **tools**, **personas**, & **targeting.**

- Includes information about intended effect
- Malware is extensible via MAEC
- Though all used through the TTP construct, should only be used individually
  - i.e. do not combine one TTP with both a malware instance and an attack pattern

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TTP

Examples

Malware	PIVY Variant
Attack	SQL Injection
Targeting	Retail Sector
Infrastructure	C2 Server = 1.23.4.5

XML: Malware

```
<stix:TTP xsi:type="ttp:TTPType" id="example:ttp-7d9fe1f7-429d-077e-db51-92c70b8da45a">
  <ttp:Title>Poison Ivy Variant v4392-acc</ttp:Title>
  <ttp:Behavior>
    <ttp:Malware>
      <ttp:Malware_Instance xsi:type="stix-maec:MAEC4.1InstanceType">
        <ttp:Type xsi:type="stixVocabs:MalwareTypeVocab-1.0">Remote Access Trojan</ttp:Type>
        <ttp:Name>Poison Ivy Variant v4392-acc</ttp:Name>
        <stix-maec:MAEC id="example:package-2fb96bef-1b11-436e-af4a-15588ac3198b" schema_version="2.1">
          <!-- MAEC Content Here -->
          <maecPackage:Malware_Subjects>
            <maecPackage:Malware_Subject id="example:Subject-57cd4839-436e-1b11-af4a-15588ac3198b">
              <maecPackage:Malware_Instance_Object_Attributes>
              </maecPackage:Malware_Instance_Object_Attributes>
            </maecPackage:Malware_Subject>
          </maecPackage:Malware_Subjects>
        </stix-maec:MAEC>
      </ttp:Malware_Instance>
    </ttp:Malware>
  </ttp:Behavior>
</stix:TTP>
```

TTP

XML: Targeting

```
<stix:TTPs>
    <stix:TTP xsi:type="ttp:TTPType" id="example:ttp-4fde045a-b25f-f035-e8d0-29c9d5130cd9"
      timestamp="2014-05-08T09:00:00.000000Z">
        <ttp:Title>Victim Targeting: Customer PII and Financial Data</ttp:Title>
        <ttp:Victim_Targeting xsi:type="ttp:VictimTargetingType">
            <ttp:Targeted_Information xsi:type="stixVocabs:InformationTypeVocab-1.0">Information Assets - Customer
            PII</ttp:Targeted_Information>
            <ttp:Targeted_Information xsi:type="stixVocabs:InformationTypeVocab-1.0">Information Assets - Financial
            Data</ttp:Targeted_Information>
        </ttp:Victim_Targeting>
    </stix:TTP>
</stix:TTPs>
```

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Exploit Target

Vulnerabilities, **weaknesses**, and **misconfigurations** in infrastructure that make it vulnerable to attack

- Includes references to CVE, CCE, and CWE
  - Extension for CVRF
- Like TTP, only use it for one at a time

Examples

Vulnerability Heartbleed (CVE-2014-0160)

Weakness Improper String Handling (CWE-89)

ExploitTarget

XML

```
<stix:Exploit_Targets>
    <stixCommon:Exploit_Target xsi:type="et:ExploitTargetType"
      id="example:et-48a276f7-a8d7-bba2-3575-e8a63fcd488"
      timestamp="2014-05-08T09:00:00.000000Z">
        <et:Title>Javascript vulnerability in MSIE 6-11</et:Title>
        <et:Vulnerability>
            <et:CVE_ID>CVE-2013-3893</et:CVE_ID>
        </et:Vulnerability>
    </stixCommon:Exploit_Target>
</stix:Exploit_Targets>
```

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Campaign

HSSEDI™

Pattern of ongoing activity with a **common purpose or goal**

- Pattern of ongoing activity is primarily via relationships
  - Incidents
  - Indicators
  - TTPs
- Includes intended effect
- Distinct from threat actor

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Examples

APT	Campaign against U.S. industry
Crime	Campaign against systems at big box retailers

Campaign

XML

```
<stix:Indicators>
    <stix:Indicator id="example:indicator-c43a0a05-e8d2-4f64-ae37-3f3fb153f8d9" timestamp="2014-09-09T19:58:39.608000+00:00"
    xsi:type='indicator:IndicatorType' negate="false" version="2.1.1">
        <indicator:Title>IP Address for known C2 Channel</indicator:Title>
        <indicator:Type xsi:type="stixVocabs:IndicatorTypeVocab-1.1">IP Watchlist</indicator:Type>
        <indicator:Observable id="example:Observable-f1712715-9bcd-404a-bf47-76504cf1232c">
            <cybox:Object id="example:Address-c4d21d91-2bea-4b19-ac53-c513f1b1bc51">
                <cybox:Properties xsi:type="AddressObj:AddressObjectType" category="ipv4-addr">
                    <AddressObj:Address_Value condition="Equals">10.0.0.0</AddressObj:Address_Value>
                </cybox:Properties>
            </cybox:Object>
        </indicator:Observable>
        <indicator:Related_Campaigns>
            <indicator:Related_Campaign>
                <stixCommon:Campaign idref="example:Campaign-b549a58c-afd9-4847-85c3-5be13d56d3cc"
                timestamp="2014-09-09T19:58:39.609000+00:00" />
            </indicator:Related_Campaign>
        </indicator:Related_Campaigns>
    </stix:Indicator>
</stix:Indicators>
<stix:Campaigns>
    <stix:Campaign id="example:Campaign-b549a58c-afd9-4847-85c3-5be13d56d3cc" timestamp="2014-09-09T19:58:39.609000+00:00"
    xsi:type='campaign:CampaignType' version="1.2">
        <campaign:Title>Operation Omega</campaign:Title>
    </stix:Campaign>
</stix:Campaigns>
```

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Threat Actor

HSSEDI™

Information about threat actor **groups** and **individuals**

- Includes:
  - Extensive identity information via OASIS CIQ
  - Assessments of maturity, intent, and resources
- Distinct from campaign

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Examples

Individual	KDZ-23, Amateur/Crime
Group	APT1, APT
ID Info	Nationality: American

ThreatActor

XML

```
<stix:Threat_Actor id="example:threatactor-dfaa8d77-07e2-4e28-b2c8-92e9f7b04428" timestamp="2014-11-19T23:39:03.893348+00:00"
  xsi:type='ta:ThreatActorType' version="1.2">
    <ta:Title>Disco Team Threat Actor Group</ta:Title>
    <ta:Identity id="example:Identity-733c5838-34d9-4fbf-949c-62aba761184c" xsi:type='stix-ciqidentity:CIQIdentity3.0InstanceType'>
        <ExtSch:Specification xmlns:ExtSch="http://stix.mitre.org/extensions/Identity#CIQIdentity3.0-1">
          <xpil:PartyName xmlns:xpil="urn:oasis:names:tc:ciq:xpil:3">
            <xnl:OrganisationName xmlns:xnl="urn:oasis:names:tc:ciq:xnl:3" xnl:Type="CommonUse">
              <xnl:NameElement>Disco Team</xnl:NameElement>
            </xnl:OrganisationName>
            <xnl:OrganisationName xmlns:xnl="urn:oasis:names:tc:ciq:xnl:3" xnl:Type="UnofficialName">
              <xnl:NameElement>Equipo del Discoteca</xnl:NameElement>
            </xnl:OrganisationName>
          </xpil:PartyName>
          <xpil:Addresses xmlns:xpil="urn:oasis:names:tc:ciq:xpil:3">
            <xpil:Address>
              <xal:Country xmlns:xal="urn:oasis:names:tc:ciq:xal:3">
                <xal:NameElement>United States</xal:NameElement>
              </xal:Country>
              <xal:AdministrativeArea xmlns:xal="urn:oasis:names:tc:ciq:xal:3">
                <xal:NameElement>California</xal:NameElement>
              </xal:AdministrativeArea>
            </xpil:Address>
          </xpil:Addresses>
          <xpil:ElectronicAddressIdentifiers xmlns:xpil="urn:oasis:names:tc:ciq:xpil:3">
            <xpil:ElectronicAddressIdentifier>disco-team@stealthemail.com</xpil:ElectronicAddressIdentifier>
            <xpil:ElectronicAddressIdentifier>facebook.com/thediscoteam</xpil:ElectronicAddressIdentifier>
          </xpil:ElectronicAddressIdentifiers>
          <xpil:Languages xmlns:xpil="urn:oasis:names:tc:ciq:xpil:3">
            <xpil:Language>Spanish</xpil:Language>
          </xpil:Languages>
        </ExtSch:Specification>
    </ta:Identity>
</stix:Threat_Actor>
```

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Course of Action

Preventative or reactive **responses to threat activity**

- Includes:
  - Assessments of cost, efficacy, etc.
  - Structured COA to represent machine-readable courses of action
- Often used from incident or indicator
  - Incident to represent

Examples

Preventative	Install patch MSKB-234
Reactive	Clean the box and rebuild

XML

```
<stix:Course_Of_Action id="example:coa-495c9b28-b5d8-11e3-b7bb-000c29789db9" xsi:type='coa:CourseOfActionType' version="1.2">
    <coa:Title>Block traffic to PIVY C2 Server (10.10.10.10)</coa:Title>
    <coa:Stage xsi:type="stixVocabs:COAStageVocab-1.0">Response</coa:Stage>
    <coa:Type xsi:type="stixVocabs:CourseOfActionTypeVocab-1.0">Perimeter Blocking</coa:Type>
    <coa:Objective>
        <coa:Description>Block communication between the PIVY agents and the C2 Server</coa:Description>
        <coa:Applicability_Confidence>
            <stixCommon:Value xsi:type="stixVocabs:HighMediumLowVocab-1.0">High</stixCommon:Value>
        </coa:Applicability_Confidence>
    </coa:Objective>
    <coa:Parameter_Observables cybox_major_version="2" cybox_minor_version="1" cybox_update_version="0">
        <cybox:Observable id="example:Observable-356e3258-0979-48f6-9bcf-6823eecf9a7d">
            <cybox:Object id="example:Address-df3c710c-f05c-4edb-a753-de4862048950">
                <cybox:Properties xsi:type="AddressObj:AddressObjectType" category="ipv4-addr">
                    <AddressObj:Address_Value>10.10.10.10</AddressObj:Address_Value>
                </cybox:Properties>
            </cybox:Object>
        </cybox:Observable>
    </coa:Parameter_Observables>
    <coa:Impact>
        <stixCommon:Value xsi:type="stixVocabs:HighMediumLowVocab-1.0">Low</stixCommon:Value>
        <stixCommon:Description>This IP address is not used for legitimate hosting so there should be no operational impact.</stixCommon:Description>
    </coa:Impact>
    <coa:Cost>
        <stixCommon:Value xsi:type="stixVocabs:HighMediumLowVocab-1.0">Low</stixCommon:Value>
    </coa:Cost>
    <coa:Efficacy>
        <stixCommon:Value xsi:type="stixVocabs:HighMediumLowVocab-1.0">High</stixCommon:Value>
    </coa:Efficacy>
</stix:Course_Of_Action>
```

Report

A collection of content **related to a single subject**

- Includes:
  - References to the content included in the report
  - Title, description, author, and other metadata
- Used to represent ”analysis reports” and other types of threat reports

Examples

Major Report	Mandiant's APT1 Report
Standard Report	IB-4232

XML

```
<stix:Report timestamp="2015-05-07T14:22:14.760467+00:00"
    id="example:Report-ab11f431-4b3b-457c-835f-59920625fe65" xsi:type='report:ReportType' version="1.0">
    <report:Header>
        <report:Title>Report on Adversary Alpha's Campaign against the Industrial Control Sector</report:Title>
        <report:Intent xsi:type="stixVocabs:ReportIntentVocab-1.0">Campaign Characterization</report:Intent>
        <report:Description>Adversary Alpha has a campaign against the ICS sector!</report:Description>
    </report:Header>
    <report:Campaigns>
        <report:Campaign idref="example:campaign-1855cb8a-d96c-4859-a450-abb1e7c061f2"
          xsi:type='campaign:CampaignType'/>
    </report:Campaigns>
</stix:Report>
```

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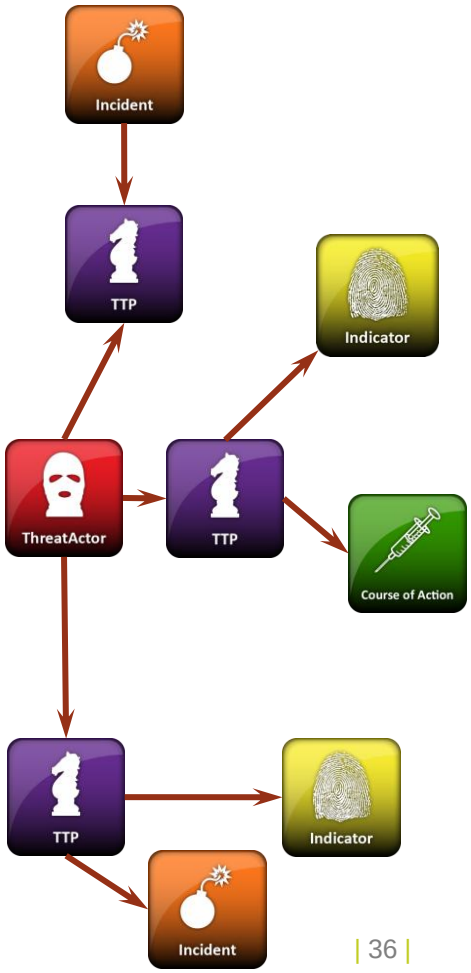
Example: Retailer Malware

You're a threat analyst at a major retailer, STB, Inc.

One of your front line employees complains about weird errors. Upon **investigating**, IT finds **BP.trojan** on their system.

Your CTI system pulls up a report from US-CERT attributing that variant to **Ugly Duckling.** They also indicate that **BlackPOS** is often used by that actor and give a **file hash** and **response options**.

Your investigation with that data uncovers several more infestations. Additionally, you discover a new variant of **BlackPOS** with a different **hash**.



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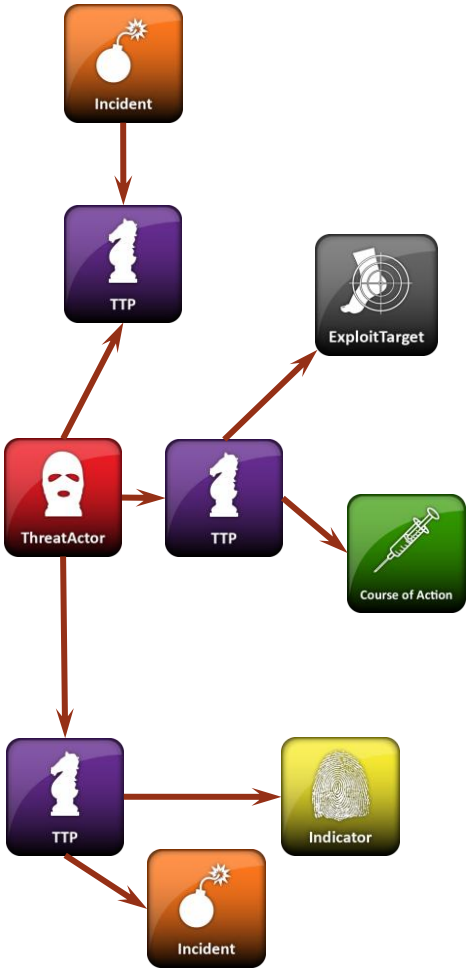
Information Sharing

What do you share?

STIX lets you choose what to share

…and what not to share

…and lets you relate it all together



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Trusted, Automated Exchange of Indicator Information

HSSEDI™

- Automated machine-to-machine sharing over HTTP
- Supports a wide variety of sharing models
- Active community of developers and analysts
- Becoming international standard in OASIS

A protocol for exchanging cyber threat intelligence.

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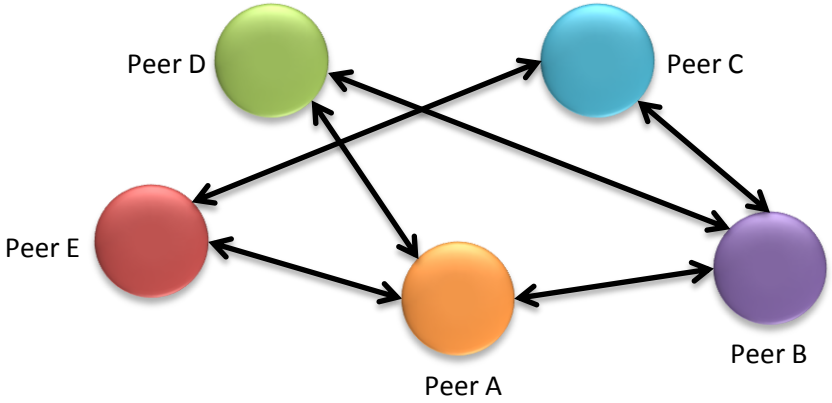
What is TAXII?

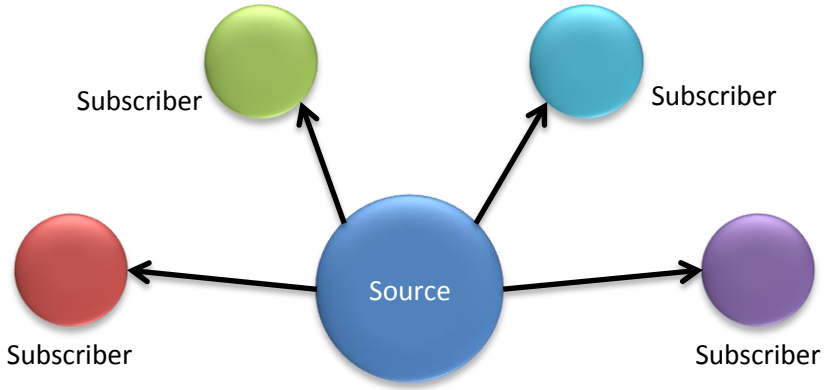
- **Standardizes exchange of cyber threat information**
- **A set of specifications any software can implement**

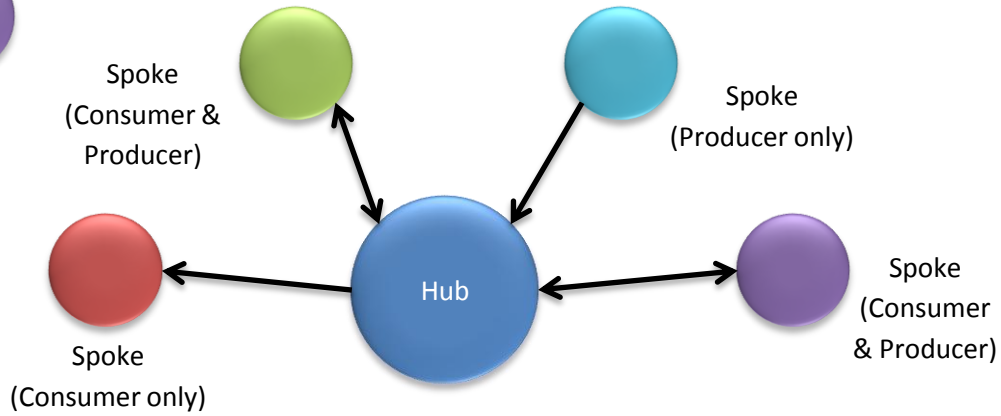
- **TAXII is NOT**
  - A specific sharing program
    - but sharing programs can use it
  - Software
    - but software can use it to share information
  - Mandate particular trust agreements or sharing
    - instead, use it to share what *you* want with the parties *you* choose

Flexible Sharing Models

- **Most sharing models are variants of these three basic models**
  - TAXII can support participation in any of these models or multiple models simultaneously







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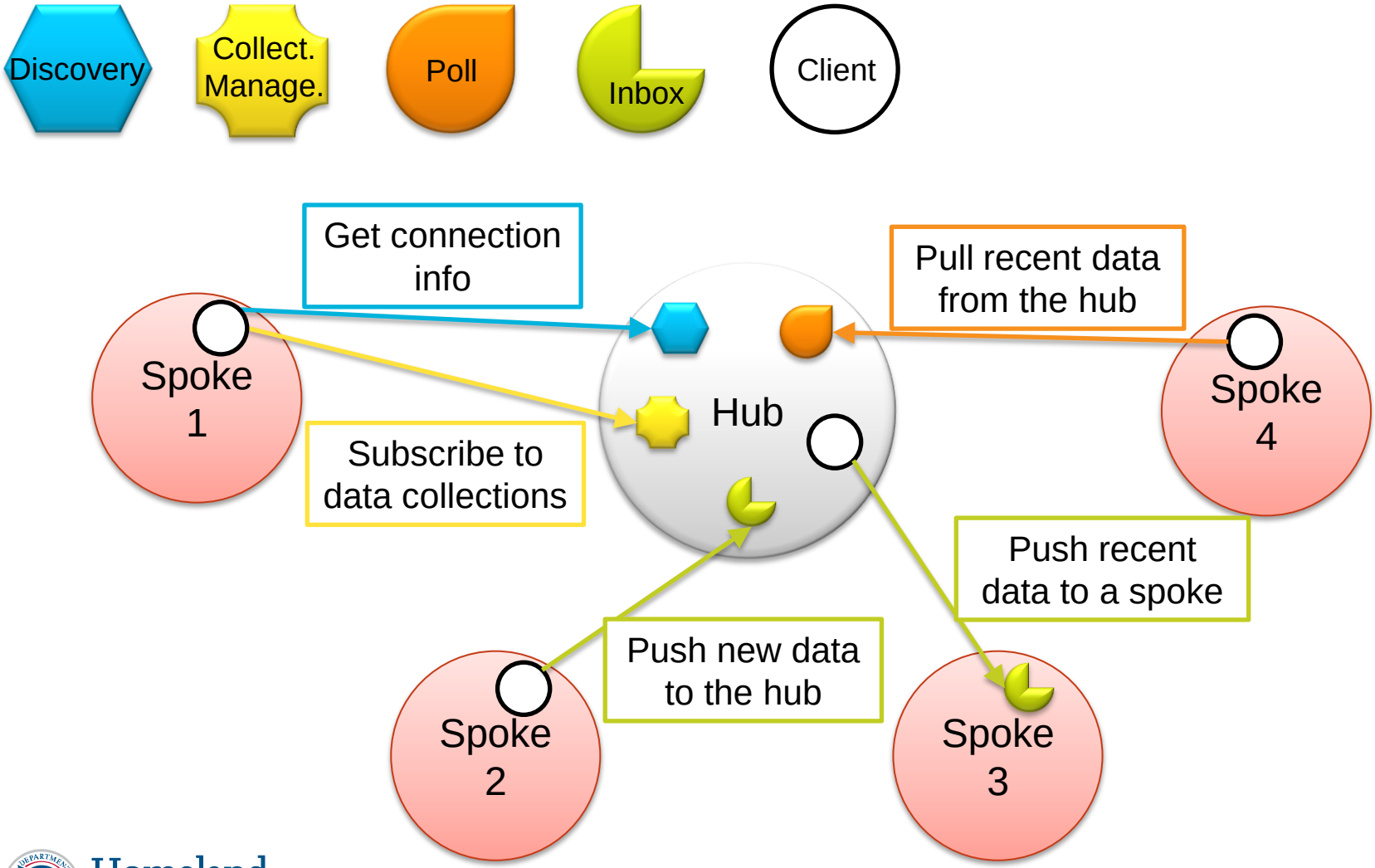
TAXII Features

- **Minimal requirements imposed on data consumers**
  - Does not require data consumers to field internet services or establish a particular security capability
- **Minimal data management requirements on data producers**
  - Does not require use of particular data management technologies or constrain how producers manage access to their data
- **Flexible sharing model support**
  - Does not force a particular sharing model on users
- **Appropriately secure communication**
  - Supports multiple security mechanisms without forcing adoption of unnecessary measures
- **Push and Pull content dissemination**
  - Users can exchange data using either or both models
- **Flexible protocol and message bindings**
  - Does not require a particular network protocol or message format

TAXII Services

- **TAXII defines four Services**
  - Discovery – A way to learn what services an entity supports and how to interact with them
  - Collection Management – A way to learn about and request subscriptions to Data Collections
  - Inbox – A way to receive pushed content (push messaging)
  - Poll – A way to request content (pull messaging)
- **Each service is optional – implement only the ones you wish**
  - You can have multiple instances of each service
- **Services can be combined in different ways for different sharing models**

Hub & Spoke Example



STIX & TAXII

Analyzing and Sharing Cyber Threat Intelligence

Homeland Security