

# MISP AND DECAYING OF INDICATORS

AN INDICATOR SCORING METHOD AND ONGOING IMPLE-

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OCTOBER 2, 2024



**MISP**  
Threat Sharing

# EXPIRING IOCs: WHY AND HOW?

- **Sharing information** about threats **is crucial**
- Organisations are sharing more and more

Contribution by **unique organisation** (Orgc.name) on MISPPriv:

| Date    | Unique Org |
|---------|------------|
| 2013    | 17         |
| 2014    | 43         |
| 2015    | 82         |
| 2016    | 105        |
| 2017    | 118        |
| 2018    | 125        |
| 2019-10 | 135        |

```
1 {  
2   "distribution": [1, 2, 3]  
3 }
```

- Various users and organisations can share data via MISP, multiple parties can be involved
    - ▶ **Trust, data quality** and **time-to-live** issues
    - ▶ Each user/organisation has **different use-cases** and interests
      - Conflicting interests such as operational security, attribution,... (depends on the user)
- Can be partially solved with *Taxonomies*

- Various users and organisations can share data via MISP, multiple parties can be involved
  - ▶ **Trust, data quality** and **time-to-live** issues
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- Can be partially solved with *Taxonomies*
- Attributes can be shared in large quantities (more than 7.3 million on MISPPRIV)
  - ▶ Partial info about their **freshness** (*Sightings*)
  - ▶ Partial info about their **validity** (last update)
- Can be partially solved with our *Decaying model*

# REQUIREMENTS TO ENJOY THE DECAYING FEATURE IN MISP

- Starting from **MISP 2.4.116**, the decaying feature is available
- Don't forget to update the decay models and enable the ones you want
- The decaying feature has no impact on the information in MISP, it's just an overlay to be used in the user-interface and API
- Decay strongly relies on *Taxonomies* and *Sightings*, don't forget to review their configuration

*Sightings* add temporal context to indicators. A user, script or an IDS can extend the information related to indicators by reporting back to MISP that an indicator has been seen, or that an indicator can be considered as a false-positive

- *Sightings* give more credibility/visibility to indicators
- This information can be used to **prioritise and decay indicators**



MISP is a peer-to-peer system, information passes through multiple instances.

- **Producers can add context** (such as tags from *Taxonomies*, *Galaxies*) about their asserted confidence or the reliability of the data
- Consumers can have **different levels of trust** in the producers and/or analysts themselves
- Users might have other contextual needs

→ Achieved thanks to *Taxonomies*

# TAXONOMIES - REFRESHER (1)

## Taxonomies

« previous 1 2 next »

| Id ↑ | Namespace                                | Description   | Version | Enabled | Required                 | Active Tags          | Actions |
|------|--|---|---------|---------|--------------------------|----------------------|---------|
| 181  | workflow                                 | Workflow support language is a common language to support intelligence analysts to perform their analysis on data and information.  | 9       | Yes     | <input type="checkbox"/> | 27 / 26 (enable all) | - 🔍 🗑️  |
| 180  | vocabulaire-des-probabilites-estimatives | Ce vocabulaire attribue des valeurs en pourcentage à certains énoncés de probabilité  | 2       | Yes     | <input type="checkbox"/> | 5 / 5                | - 🔍 🗑️  |
| 179  | threats-to-dns                           | An overview of some of the known attacks related to DNS as described by Torabi, S., Boukhlouta, A., Assi, C., & Debbabi, M. (2018) in Detecting Internet Abuse by Analyzing Passive DNS Traffic: A Survey of Implemented Systems. IEEE Communications Surveys & Tutorials, 1–1. doi:10.1109/comst.2018.2849614                    | 1       | No      | <input type="checkbox"/> | 0 / 18               | + 🔍 🗑️  |
| 178  | targeted-threat-index                    | The Targeted Threat Index is a metric for assigning an overall threat ranking score to email messages that deliver malware to a victim's computer. The TTI metric was first introduced at SecTor 2013 by Seth Hardy as part of the talk "RATastrophe: Monitoring a Malware Menagerie" along with Katie Kleemola and Greg Wiseman. | 2       | Yes     | <input type="checkbox"/> | 11 / 11              | - 🔍 🗑️  |

- Tagging is a simple way to attach a classification to an *Event* or an *Attribute*
- Classification must be globally used to be efficient

# TAXONOMIES - REFRESHER (2)

## ADMIRALTY-SCALE Taxonomy Library

|                    |   |
|--------------------|---|
| <b>Id</b>          | 127   |
| <b>Namespace</b>   | admiralty-scale   |
| <b>Description</b> | The Admiralty Scale or Ranking (also called the NATO System) is used to rank the reliability of a source and the credibility of an information. Reference based on FM 2-22.3 (FM 34-52) HUMAN INTELLIGENCE COLLECTOR OPERATIONS and NATO documents. |
| <b>Version</b>     | 4   |
| <b>Enabled</b>     | Yes (disable)   |

- previous   next -

| <input type="checkbox"/> Tag   | Expanded  | Numerical value | Events | Attributes | Tags  | Action |
|--|---|-----------------|--------|------------|---|--------|
| <input type="checkbox"/> admiralty-scale:information-credibility="1" | Information Credibility: Confirmed by other sources | 100             | 6      | 0          | admiralty-scale:information-credibility="1" | ⏪ ⏩ -  |
| <input type="checkbox"/> admiralty-scale:information-credibility="2" | Information Credibility: Probably true              | 75              | 21     | 1          | admiralty-scale:information-credibility="2" | ⏪ ⏩ -  |
| <input type="checkbox"/> admiralty-scale:information-credibility="3" | Information Credibility: Possibly true              | 50              | 16     | 5          | admiralty-scale:information-credibility="3" | ⏪ ⏩ -  |
| <input type="checkbox"/> admiralty-scale:information-credibility="4" | Information Credibility: Doubtful                   | 25              | 2      | 0          | admiralty-scale:information-credibility="4" | ⏪ ⏩ -  |
| <input type="checkbox"/> admiralty-scale:information-credibility="5" | Information Credibility: Improbable                 | 0               | 1      | 0          | admiralty-scale:information-credibility="5" | ⏪ ⏩ -  |
| <input type="checkbox"/> admiralty-scale:information-credibility="6" | Information Credibility: Truth cannot be judged     | 50              | 9      | 2          | admiralty-scale:information-credibility="6" | ⏪ ⏩ -  |
| <input type="checkbox"/> admiralty-scale:source-reliability="a"      | Source Reliability: Completely reliable             | 100             | 1      | 0          | admiralty-scale:source-reliability="a"      | ⏪ ⏩ -  |
| <input type="checkbox"/> admiralty-scale:source-reliability="b"      | Source Reliability: Usually reliable                | 75              | 21     | 76         | admiralty-scale:source-reliability="b"      | ⏪ ⏩ -  |
| <input type="checkbox"/> admiralty-scale:source-reliability="c"      | Source Reliability: Fairly reliable                 | 50              | 9      | 8          | admiralty-scale:source-reliability="c"      | ⏪ ⏩ -  |
| <input type="checkbox"/> admiralty-scale:source-reliability="d"      | Source Reliability: Not usually reliable            | 25              | 2      | 0          | admiralty-scale:source-reliability="d"      | ⏪ ⏩ -  |
| <input type="checkbox"/> admiralty-scale:source-reliability="e"      | Source Reliability: Unreliable                      | 0               | 0      | 0          | admiralty-scale:source-reliability="e"      | ⏪ ⏩ -  |
| <input type="checkbox"/> admiralty-scale:source-reliability="f"      | Source Reliability: Reliability cannot be judged    | 50              | 10     | 7          | admiralty-scale:source-reliability="f"      | ⏪ ⏩ -  |
| <input type="checkbox"/> admiralty-scale:source-reliability="g"      | Source Reliability: Deliberately deceptive          | 0               | N/A    | N/A        |   | +      |

→ Cherry-pick allowed Tags

- Some taxonomies have `numerical_value`
  - Can be used to prioritise *Attributes*

| Description                  | Value |
|------------------------------|-------|
| Completely reliable          | 100   |
| Usually reliable             | 75    |
| Fairly reliable              | 50    |
| Not usually reliable         | 25    |
| Unreliable                   | 0     |
| Reliability cannot be judged | 50 ?  |
| Deliberately deceptive       | 0 ?   |

| Description                | Value |
|----------------------------|-------|
| Confirmed by other sources | 100   |
| Probably true              | 75    |
| Possibly true              | 50    |
| Doubtful                   | 25    |
| Improbable                 | 0     |
| Truth cannot be judged     | 50 ?  |

$$\text{score}(\text{Attribute}) = \text{base\_score}(\text{Attribute}, \text{Model}) \bullet \text{decay}(\text{Model}, \text{time})$$

Where,

- $\text{score} \in [0, +\infty$
- $\text{base\_score} \in [0, 100]$
- $\text{decay}$  is a function defined by model's parameters controlling decay speed
- $\text{Attribute}$  Contains *Attribute's* values and metadata (*Taxonomies, Galaxies, ...*)
- $\text{Model}$  Contains the *Model's* configuration

# CURRENT IMPLEMENTATION IN MISP

# IMPLEMENTATION IN MISP: Event/view

The screenshot displays the MISP interface for viewing an event. At the top, there are navigation tabs: Photos, Galaxy, Event graph, Correlation graph, ATTACK matrix, Attributes, and Discussion. Below this, a search bar contains the text "45: Decay...". A "Galaxies" section is visible with a search icon and a plus sign. Below that, there are navigation buttons: "previous", "next", and "view all".

The main content area shows a table of events. The table has columns for Date, Org, Category, Type, Value, Tags, Galaxies, Comment, Correlate, Related Events, Feed hits, IDS, Distribution, Sightings, Activity, Score, and Actions. The "Decay score" toggle is active, and the "Filtering tool (1)" is also active.

| Date       | Org | Category         | Type   | Value   | Tags  | Galaxies | Comment | Correlate | Related Events             | Feed hits    | IDS | Distribution | Sightings | Activity | Score   | Actions |
|------------|-----|------------------|--------|---------|---|----------|---------|-----------|----------------------------|--------------|-----|--------------|-----------|----------|---|---------|
| 2019-09-12 |     | Network activity | ip-src | 5.5.5.5 |   |          |         |           |                            |              |     | Inherit      | (0/0)     |          | NIDS Simple Decaying ... 65.26<br>Model 5 79.88 |         |
| 2019-08-13 |     | Network activity | ip-src | 8.8.8.8 | adm_rality_scale:source-reliability="A"<br>retention:expired  |          |         |           | 1 2 2 2<br>Show 11 more... | S1.1<br>S1.2 |     | Inherit      | (5/0)     |          | NIDS Simple Decaying ... 54.6<br>Model 5 52.69  |         |
| 2019-08-13 |     | Network activity | ip-src | 9.9.9.9 | adm_rality_scale:source-reliability="C"<br>misp:confidence-level="completely-confident"<br>Ipnumber |          |         |           | 1 3 1 9<br>Show 6 more...  | S1.1         |     | Inherit      | (4/1)     |          | NIDS Simple Decaying ... 37.43<br>Model 5 0     |         |
| 2019-08-13 |     | Network activity | ip-src | 7.7.7.7 | adm_rality_scale:information-credibility="4"<br>retention:20  |          |         |           | 41                         |              |     | Inherit      | (3/0)     |          | NIDS Simple Decaying ... 37.41<br>Model 5 0     |         |
| 2019-07-18 |     | Network activity | ip-src | 6.6.6.6 |   |          |         |           | 41                         |              |     | Inherit      | (0/0)     |          | NIDS Simple Decaying ... 23.31<br>Model 5 0     |         |

## ■ Decay score toggle button

- ▶ Shows Score for each Models associated to the Attribute type

# IMPLEMENTATION IN MISP: API RESULT

/attributes/restSearch

```
1 "Attribute": [  
2   {  
3     "category": "Network activity",  
4     "type": "ip-src",  
5     "to_ids": true,  
6     "timestamp": "1565703507",  
7     [...]  
8     "value": "8.8.8.8",  
9     "decay_score": [  
10      {  
11        "score": 54.475223849544456,  
12        "decayed": false,  
13        "DecayingModel": {  
14          "id": "85",  
15          "name": "NIDS Simple Decaying Model"  
16        }  
17      }  
18    ],  
19  [...]
```

- **Automatic scoring** based on default values
- **User-friendly UI** to manually set *Model* configuration (lifetime, decay, etc.)
- **Simulation** tool
- Interaction through the **API**
- Opportunity to create your **own** formula or algorithm

# DECAYING MODELS IN DEPTH

# SCORING INDICATORS: base\_score (1)

$$\text{score}(\text{Attribute}) = \text{base\_score}(\text{Attribute}, \text{Model}) \bullet \text{decay}(\text{Model}, \text{time})$$

When scoring indicators<sup>1</sup>, multiple parameters<sup>2</sup> can be taken into account. The **base score** is calculated with the following in mind:

- Data reliability, credibility, analyst skills, custom prioritisation tags (economical-impact), etc.
- Trust in the source

$$\text{base\_score} = \omega_{tg} \cdot \text{tags} + \omega_{sc} \cdot \text{source\_confidence}$$

Where,

$$\omega_{sc} + \omega_{tg} = 1$$

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<sup>1</sup>Paper available: <https://arxiv.org/pdf/1803.11052>

<sup>2</sup>at a variable extent as required

## SCORING INDICATORS: base\_score (2)

Current implementation ignores source\_confidence:

→  $\text{base\_score} = \text{tags}$

| Tag  | Computation |   |                 | Result       |
|--|-------------|---|-----------------|--------------|
|  | Eff. Ratio  |   | numerical_value |              |
| admiralty-scale:source-reliability="Completely reliable" | 0.50        | * | 100.00          | 50.00        |
| phishing:psychological-acceptability="high"              | 0.50        | * | 75.00           | 37.50        |
|  |             |   |                 | <b>87.50</b> |

→ The base\_score can be use to prioritize attribute based on their attached context and source

$$\text{score}(\text{Attribute}) = \text{base\_score}(\text{Attribute}, \text{Model}) \bullet \text{decay}(\text{Model}, \text{time})$$

The decay is calculated using:

- The lifetime of the indicator
  - ▶ May vary depending on the indicator type
  - ▶ short for an IP, long for an hash
- The decay rate, or speed at which an attribute loses score over time
- The time elapsed since the latest update or sighting

→ decay rate is **re-initialized upon sighting** addition, or said differently, the score is reset to its base score as new *sightings* are applied.

$$\text{score} = \text{base\_score} \cdot \left( 1 - \left( \frac{t}{\tau} \right)^{\frac{1}{\delta}} \right)$$

- $\tau$  = lifetime
- $\delta$  = decay speed

$$\mapsto score = base\_score \cdot \left(1 - \left(\frac{t}{\tau}\right)^{\frac{1}{\delta}}\right)$$

*Models* are an instantiation of the formula where elements can be defined:

- Parameters: *lifetime*, *decay\_rate*, *threshold*
- *base\_score*
- *default base\_score*
- *formula*
- *associate Attribute types*
- *creator organisation*

Multiple model types are available

- **Default Models:** Models created and shared by the community. Available from `misp-decaying-models` repository<sup>3</sup>.
  - ▶ → Not editable
- **Organisation Models:** Models created by a user belonging to an organisation
  - ▶ These models can be hidden or shared to other organisation
  - ▶ → Editable

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<sup>3</sup><https://github.com/MISP/misp-decaying-models.git>



# IMPLEMENTATION IN MISP: FINE TUNING TOOL

**Decaying Of Indicator Fine Tuning Tool**

Attributes: Show All Types | Show MISP Objects | Search Attribute Type

| Attribute Type      | Category         | Model ID |
|---------------------|------------------|----------|
| aba-rtn             | Financial fraud  |          |
| authen@hash         | Payload delivery |          |
| bank-account-iv     | Financial fraud  |          |
| bc                  | Financial fraud  |          |
| bin                 | Financial fraud  |          |
| bro                 | Network activity | 10 11    |
| bc                  | Financial fraud  | 11       |
| cc-number           | Financial fraud  |          |
| cd@hash             | Payload delivery |          |
| community-id        | Network activity |          |
| domain              | Network activity |          |
| domain@ip           | Network activity | 10 94    |
| email-attachment    | Payload delivery |          |
| email-@ip           | Network activity | 11       |
| email-@ic           | Payload delivery |          |
| headers             | Payload delivery |          |
| headers/authen@hash | Payload delivery |          |
| headers@ipfuzzy     | Payload delivery |          |
| headers@ip@hash     | Payload delivery |          |
| headers@ip@id       | Payload delivery | 12       |
| headers@ip@hash     | Payload delivery | 13       |
| headers@ip@h1       | Payload delivery | 13       |

Polynomial

Adjust base score | Simulate this model

Expire after (lifetime) | 1 days and 7 hours  
Score halved after (Half-life) | 0 day and 6 hours

Phishing model | Simple model to rapidly decay | Rate

| Parameters |                |        |   |            |          |             |           |                   |                                |   |       |         |            |
|------------|----------------|--------|---|------------|----------|-------------|-----------|-------------------|--------------------------------|---|-------|---------|------------|
| ID         | Model Name     | Org ID | Description                                     | Formula    | Lifetime | Decay speed | Threshold | Default basescore | Basescore config               | # | Types | Enabled | Action     |
| 29         | Phishing model | 1      | Simple model to rapidly decay phishing website. | Polynomial | 3        | 2.3         | 30        | 80                | estimate-language phishing 0.5 | 9 |       | ✓       | Load model |

Create, modify, visualise, perform mapping

# IMPLEMENTATION IN MISP: base\_score TOOL

Search Taxonomy  x

Default basescore 80

**3 not having numerical value**

| Taxonomies                      | Weight |
|---------------------------------|--------|
| <b>admiralty-scale</b>          |        |
| source-reliability              | 31     |
| information-credibility         | 30     |
| <b>priority-level</b>           |        |
| priority-level                  | 53     |
| <b>retention</b>                |        |
| retention                       | 0      |
| <b>estimative-language</b>      |        |
| likelihood-probability          | 0      |
| confidence-in-analytic-judgment | 0      |
| <b>misp</b>                     |        |
| confidence-level                | 0      |
| threat-level                    | 0      |
| automation-level                | 0      |
| <b>phishing</b>                 |        |
| state                           | 0      |
| psychological-acceptability     | 0      |
| <b>Excluded</b>                 |        |

Placeholder for "Organisation source confidence"

### Example [↗](#)

| Attribute          | Tags  | Base score                              |
|--------------------|---|---|
| Tag your attribute | <span style="background-color: black; color: white; padding: 2px;">+</span>   |   |
| Attribute 1        | <span style="background-color: #90EE90; padding: 2px;">admiralty-scale:information-credibility="3"</span>   | 0.0 <span style="color: red;">?</span>  |
| Attribute 2        | <span style="background-color: #90EE90; padding: 2px;">priority-level:baseline-minor</span> <span style="background-color: #90EE90; padding: 2px;">admiralty-scale:source-reliability="d"</span><br><span style="background-color: #90EE90; padding: 2px;">admiralty-scale:information-credibility="2"</span> | 38.2 <span style="color: red;">?</span> |
| Attribute 3        | <span style="background-color: #FF0000; padding: 2px;">priority-level:severe</span> <span style="background-color: #90EE90; padding: 2px;">admiralty-scale:information-credibility="2"</span>   | 84.6 <span style="color: red;">?</span> |

### Computation steps

| Tag   | Computation |         | Result |
|---|-------------|---------|--------|
|   | Eff. Ratio  | Value   |        |
| <span style="background-color: #0000FF; color: white; padding: 2px;">priority-level:baseline-minor</span> | 0.46        | * 25.00 | 11.62  |
| <span style="background-color: #90EE90; padding: 2px;">admiralty-scale:source-reliability="d"</span>      | 0.27        | * 25.00 | 6.80   |

# IMPLEMENTATION IN MISP: SIMULATION TOOL

NIDS Simple Decaying Model

RestSearch [Specific ID](#)

**Attribute RestSearch®**

```
{
  "includeDecayScore": 1,
  "includeFullModel": 0,
  "score": 30,
  "includeDecayed": 0,
  "decayingModel": [8],
  "tag_id": 1,
  "tags": ["estimative-language"], "priority-levels": "interior", "timestamp": "2019-08-13"
}
```

[Search](#)

**Base score** Base score configuration not set. But default value sets.

| Tag  | Computation | ERT | Ratio  | Value | Result |
|--|-------------|-----|--------|-------|--------|
| <code>resp.confidence-level="usually-confident"</code> | 0           | X   | 75.00  | 0     |        |
| <code>resp.confidence-level="fairly-confident"</code>  | 0           | X   | 50.00  | 0     |        |
| <code>generally-scale:source-reliability="x"</code>    | 0           | X   | 100.00 | 0     |        |
| <code>retention:expired</code>                         | 0           | X   | NaN    | 0     |        |
| <code>base_score</code>                                |             |     |        |       | 88.00  |

Sighting: Wed Sep 4 12:18:09 2019 | Current score: 54.60

The graph plots the score over time from August to December 2019. The y-axis represents the score from 0 to 100. The x-axis represents the month. The score starts at 88.00 in August and decays exponentially towards 0. A red shaded area is present at the bottom of the graph, representing a score threshold. A vertical line is drawn at the end of September, indicating the current score of 54.60.

| ID    | Event # | Date       | Org      | Category         | Type   | Value   | Tags  | Event Tags  | Galaxies | Comment | IDS | Sightings | Score                          |
|-------|---------|------------|----------|------------------|--------|---------|---|---|----------|---------|-----|-----------|--------------------------------|
| 36758 | 45      | 2019-08-13 | ORIGNAME | Network activity | ip-sic | 7.7.7.7 | <code>generally-scale:information-credibility="x"</code><br><code>retention:2d</code> | <code>resp.confidence-level="usually-confident"</code><br><code>resp.confidence-level="fairly-confident"</code> |          |         | ✓   |           | NIDS Simple Decaying ... 37.41 |
| 36757 | 45      | 2019-08-13 | ORIGNAME | Network activity | ip-sic | 8.8.8.8 | <code>generally-scale:source-reliability="x"</code><br><code>retention:expired</code> | <code>resp.confidence-level="usually-confident"</code><br><code>resp.confidence-level="fairly-confident"</code> |          |         | ✓   |           | NIDS Simple Decaying ... 54.6  |

Page 1 of 1, showing 2 records out of 2 total, starting on record 1, ending on 2

Simulate Attributes with different Models

/attributes/restSearch

```
1 {  
2     "includeDecayScore": 1,  
3     "includeFullModel": 0,  
4     "excludeDecayed": 0,  
5     "decayingModel": [85],  
6     "modelOverrides": {  
7         "threshold": 30  
8     }  
9     "score": 30,  
10 }  
11
```

# CREATING A NEW DECAY ALGORITHM (1)

The current architecture allows users to create their **own** formulae.

1. Create a new file `$filename` in `app/Model/DecayingModelsFormulas/`
2. Extend the Base class as defined in `DecayingModelBase`
3. Implement the two mandatory functions `computeScore` and `isDecayed` using your own formula/algorithm
4. Create a Model and set the formula field to `$filename`

Use cases:

- Add support for **more feature** (expiration taxonomy)
- **Query external services** then influence the score
- Completely **different approach** (i.e streaming algorithm)
- ...

## CREATING A NEW DECAY ALGORITHM (2)

```
1 <?php
2 include_once 'Base.php';
3
4 class Polynomial extends DecayingModelBase
5 {
6     public const DESCRIPTION = 'The description of your new
7     decaying algorithm';
8
9     public function computeScore($model, $attribute, $base_score,
10     $elapsed_time)
11     {
12         // algorithm returning a numerical score
13     }
14
15     public function isDecayed($model, $attribute, $score)
16     {
17         // algorithm returning a boolean stating
18         // if the attribute is expired or not
19     }
20 }
```

# DECAYING MODELS 2.0

- Improved support of *Sightings*
  - ▶ False positive *Sightings* should somehow reduce the score
  - ▶ Expiration *Sightings* should mark the attribute as decayed
- Potential *Model* improvements
  - ▶ Instead of resetting the score to `base_score` once a *Sighting* is set, the score should be increased additively (based on a defined coefficient); thus **prioritizing surges** rather than infrequent *Sightings*
  - ▶ Take into account related *Tags* or *Correlations* when computing score
- Increase *Taxonomy* coverage
  - ▶ Users should be able to manually override the `numerical_value` of *Tags*
- For specific type, take into account data from other services
  - ▶ Could fetch data from *BGP ranking*, *Virus Total*, *Passive X* for IP/domain/... and adapt the score