TOWARDS A UNIFIED DATA STORAGE AND GENERIC VISUALIZATIONS IN CYBER RANGES

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Cyber Ranges

- Emulate computer networks
- Enables to perform cyber security exercises and experiments
- They differ in
  - emulation possibilities (traffic emulation),
  - application domain (training, learning, forensic analysis),
  - architecture (IaaS, PaaS, **SaaS**, ...)
  - ...

Cyber Ranges – Common Features

Common services provided by cyber ranges:

- *Resource management* – allocation of network infrastructure with required topology and running applications.
- *Interaction of users with hosts* – allowing users to log into hosts and run applications there.
- ***Data monitoring*** – network activities are monitored on the fly and measured data is stored for further analysis and mediation to users.
- ***Providing insight into cyber threats*** – by providing users with interactive visualizations, analytical tools, and other interactive techniques.

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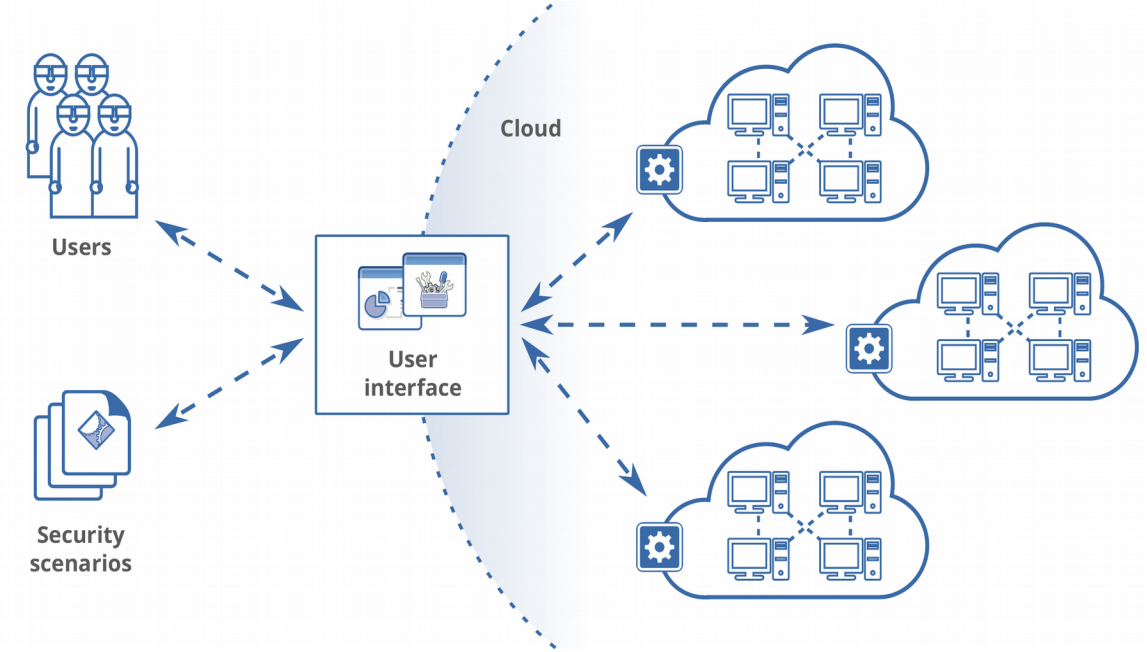
KYPO Cyber Range – Key Features

- **Cloud-based** virtualization
  - Allocation of (multiple) sandboxes on demand
  - SW emulation of links, switches, hosts, ...
- Generic cyber range supporting **user-defined security scenarios**
- Goal: KYPO **as a service** (SaaS)
  - End users can interact with sandboxes easily via predefined user interfaces and without the need to install anything by themselves



Challenge 1: Data Monitoring

Data monitoring

- We do not know in advance what data are to be monitored for particular scenario.
- **Common phenomena** monitored natively
  - Ex.: packets, flows, CPU load
- **Scenario-specific phenomena** monitored by specialized probes integrated to the cyber range infrastructure
  - Ex.: availability of services, average link throughput, ...
  - Requires access to the virtualization layer or to the low-level cyber range infrastructure
  - Requires skills, competences and deep knowledge of the cyber range
  - It is annoying and time consuming for end users (domain experts)
- **Goal:** Provide a unified data monitoring and storage infrastructure at the user level (as a service)

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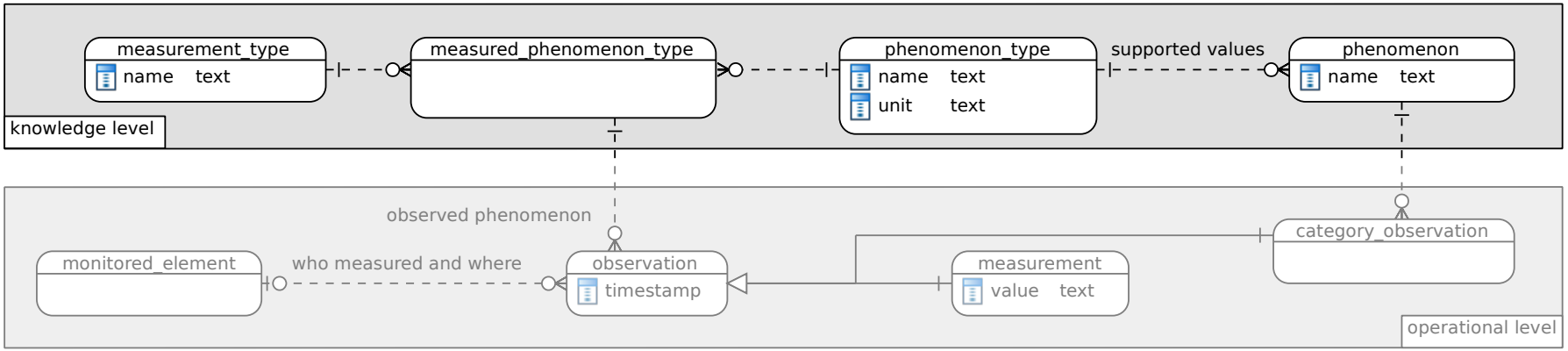
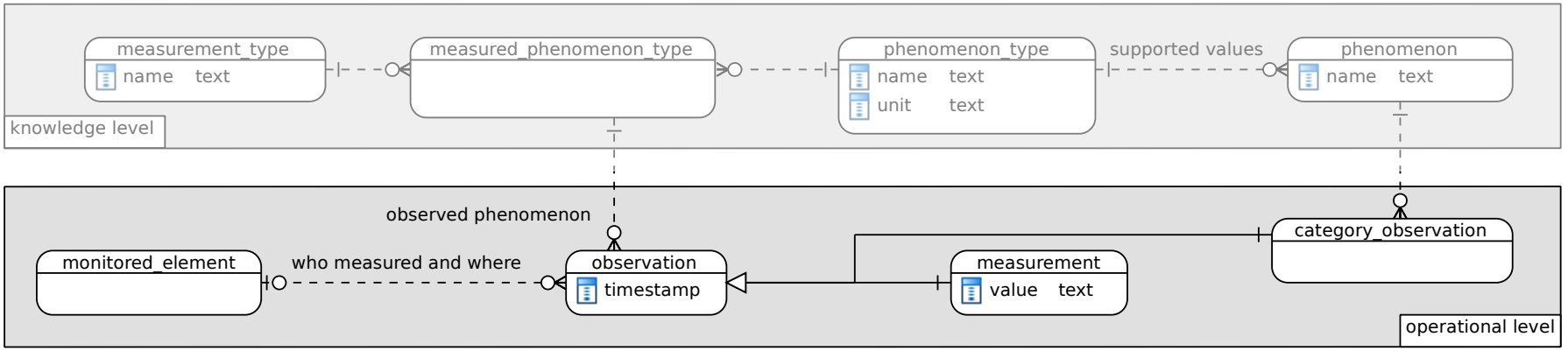
Unified Scheme for Data Storage

- Adapted *Observation* pattern of Martin Fowler
- **Knowledge level**
  - What is to be measured => **scenario-specific data**
  - `phenomenon_type` = common network phenomena
  - `phenomenon` = predefined values of network phenomena
  - `measurement_type` = aggregated data (higher-level interpretation, e.g. *average throughput in 5 min interval*)



Unified Scheme for Data Storage (cont.)

- **Operational level**
  - Data measured by probes => **exercise-specific data**
  - `measurement` = value from "unlimited" domain (e.g. numerical)
  - `category_observation` = predefined value



Challenge 2: Data Visualization

Mediation of data to users

- Variable data
  - Scenario-specific data
- Variable user interests
  - The same data analyzed in different ways by different domain experts
- **Approach 1:** Use specialized analytical or visualization tools deployed in sandboxes by users themselves
  - Tools usually require a specific format of data sources => adaptation of the monitoring infrastructure
- **Approach 2:** Provide user interfaces as a service
  - A scenarist composes scenario-specific user interfaces from predefined visual/interactive blocks
  - End users (domain experts) utilize them directly

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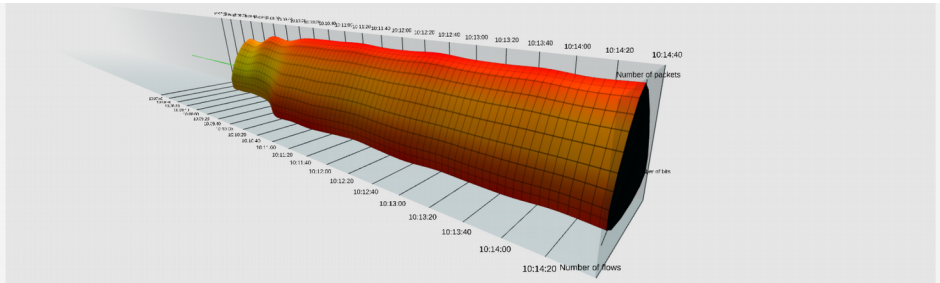
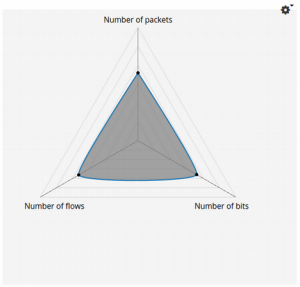
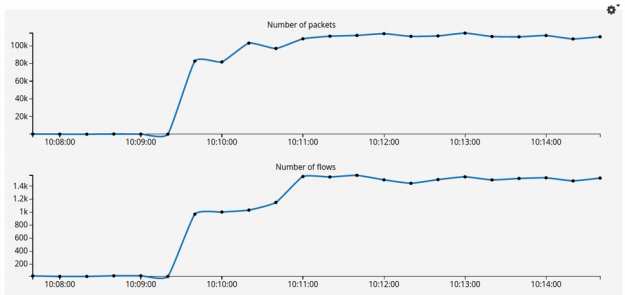
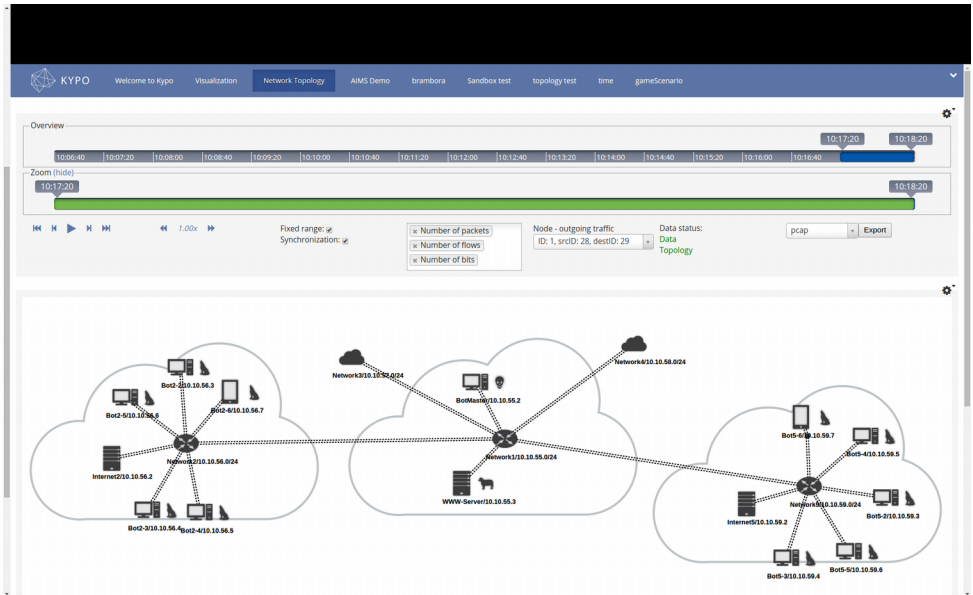
Adaptable User Interfaces

- Enterprise web portals (JSR 168 and JSR 286)
- *Portlets* integrated to *page templates* and *site templates* interactively at the user level
- Portlets:
  - Narrowly focused
  - Mutually connectable to provide higher-level interactions
  - Highly configurable









Evaluation

- Attack demonstrations
  - DDOS and phishing scenarios for security experts
- Hacking games
  - Cca 10 capture-the-flag games
  - From kids to security experts
- Cyber Czech Defense Exercise
  - Realistic 2 days defense exercise in the cooperation with Czech National Security Authority
  - 6 runs, complex scenario with 5 defending and 1 attacking teams
- KYPO Lab – regular cyber-security course
  - Students design their own security scenarios inspired by real threats and attacks
  - Other students play these scenarios at the end of semester

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Conclusion and Future Work

- Unified monitoring.
  - Setting up the monitoring infrastructure is very laborious and still far from automation.
- NoSQL databases.
  - Possibly better adaptation to variable data.
  - Do not solve the problem of data interpretation and mediation to users.
- Configurability of portlets.
  - Visualization and interaction features depending on dynamic (scenario-specific) roles, e.g. attacker vs. defender.

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Questions?

Thank you for your attention

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