Extending TimeMap: novel visualization and better ML tools

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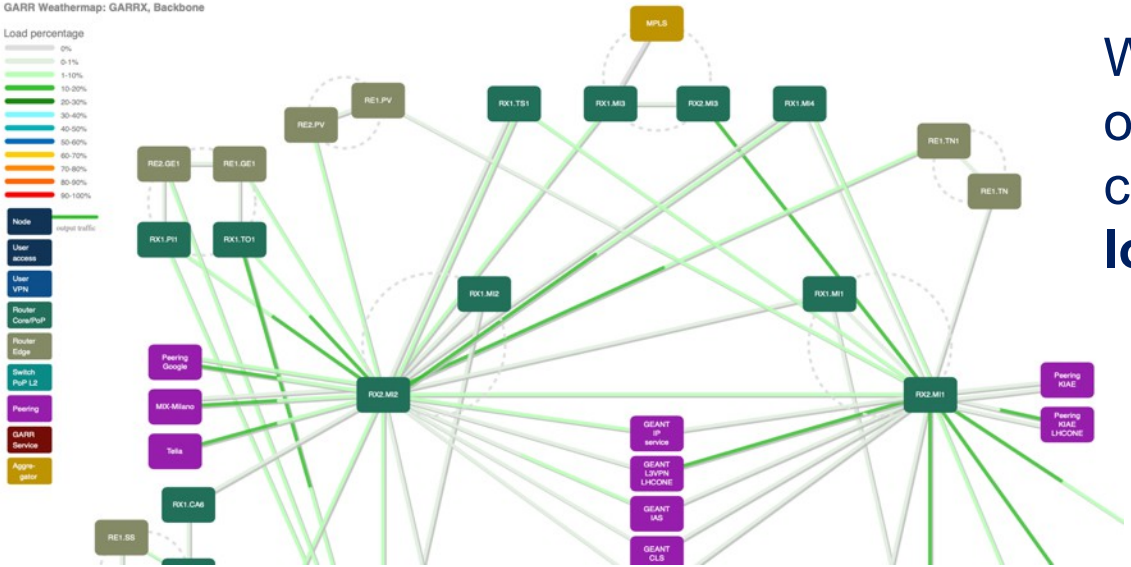
Outline

- Why TimeMap and current status
- GUI enhancement for new use-cases
- More on Anomaly Detection

Network Traffic: what do we usually monitor?



Weather map are usually optimized for display capacity,
load in bit/sec

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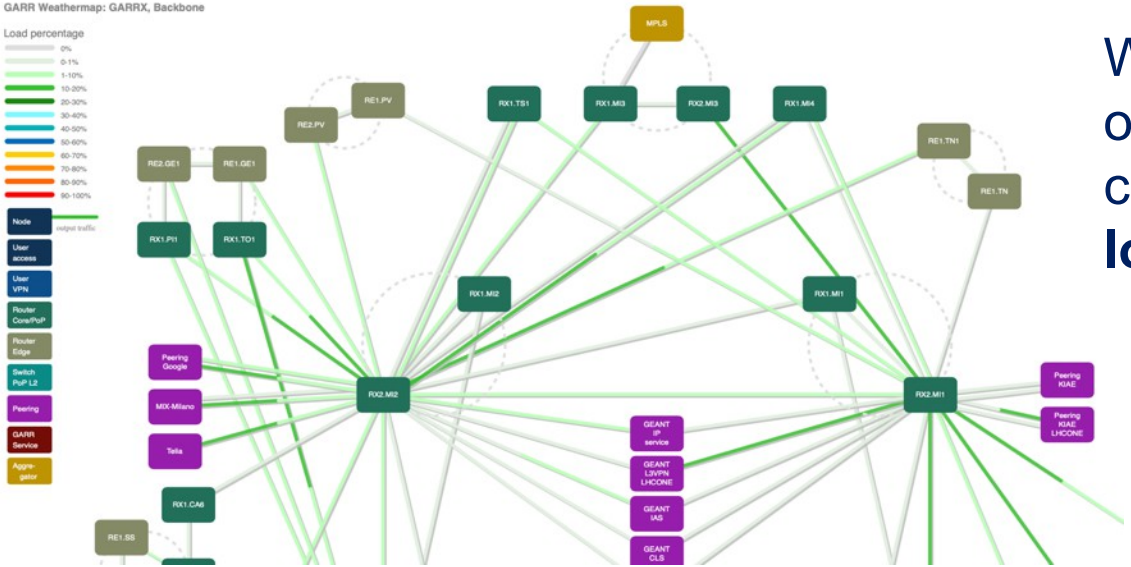
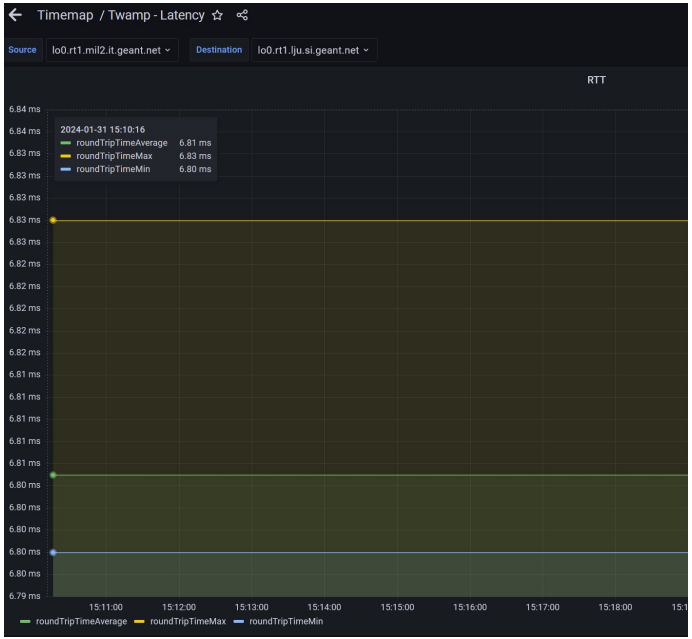


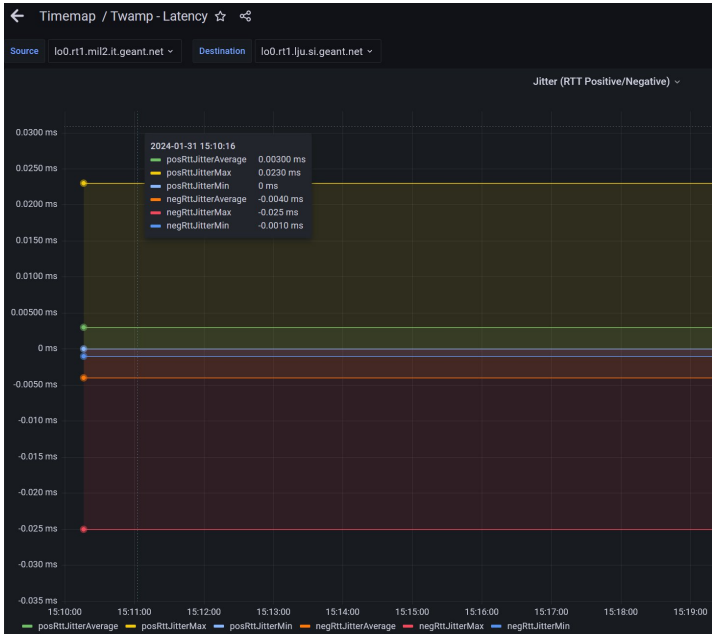
Weather map are usually optimized for display capacity,
load in bit/sec

...OK for bulk data transfers only!

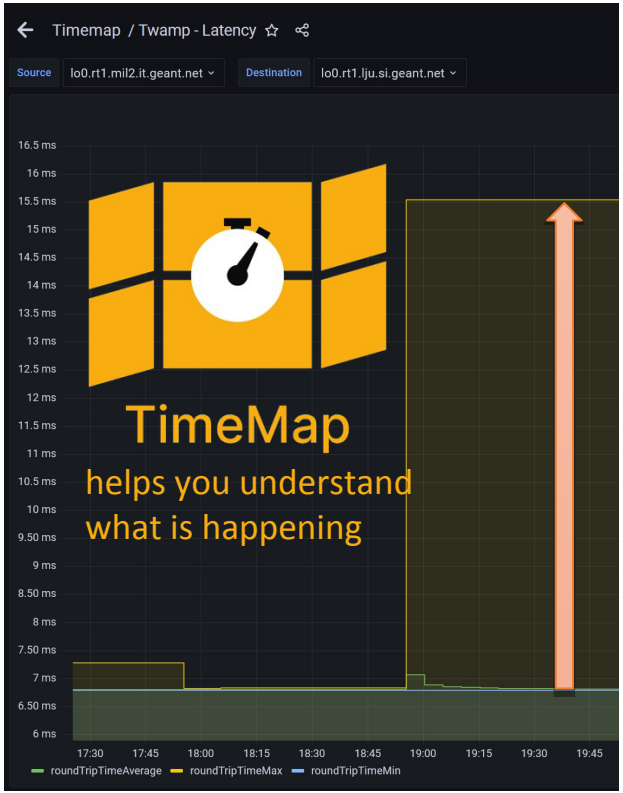
LOLA, a real-time application sensitive to Latency & Jitter

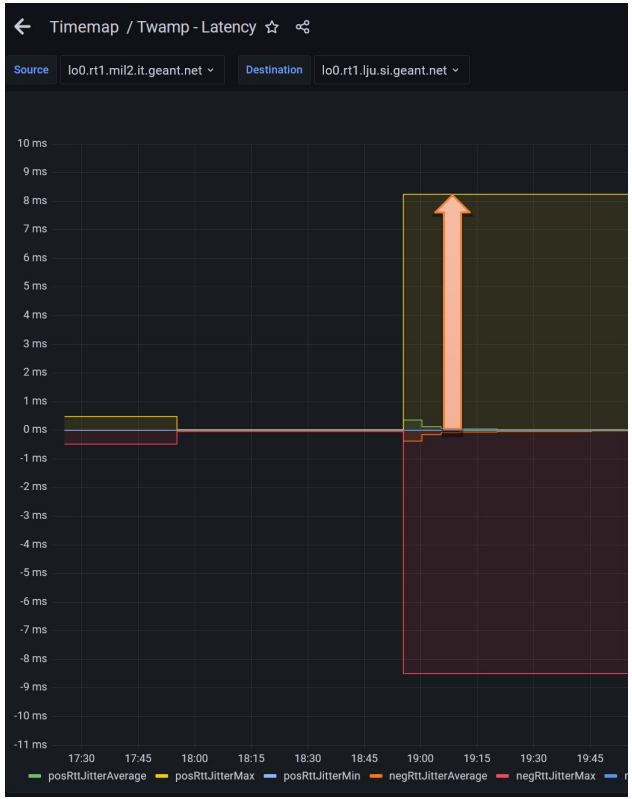
Active measurements – all network segments good





During the rehearsal… 😟





Why TimeMap

We need to monitor ”the hidden”

- latency
- jitter

We need to keep track of ”the hidden”

- historic series

We need to find anomalies in “the hidden”

- machine learning
- alarms
- call the right NOC for the right network segment

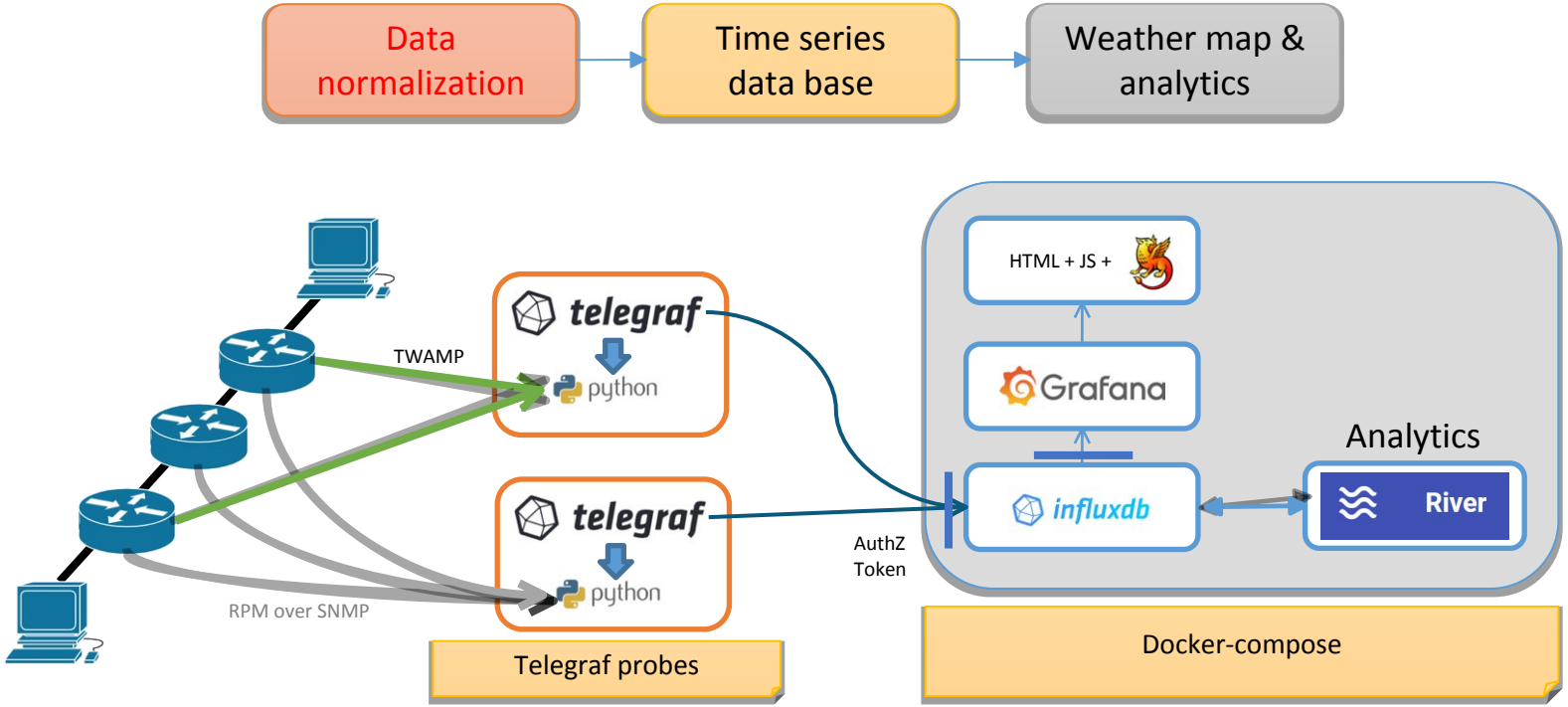
TimeMap technical requirements

- **Agile design:**
  - Scalable micro-services, easy to deploy, **minimal custom code**
  - As neutral as possible: **monitoring standards and FOSS**

- Security, with federated access control
  - **eduGAIN** authentication
  - Role Based Access Control, API tokens, multi-tenancy

- **Dynamic**: almost no changes needed when networks change

TimeMap architecture



Current Status: TimeMap instance for the GÈANT backbone

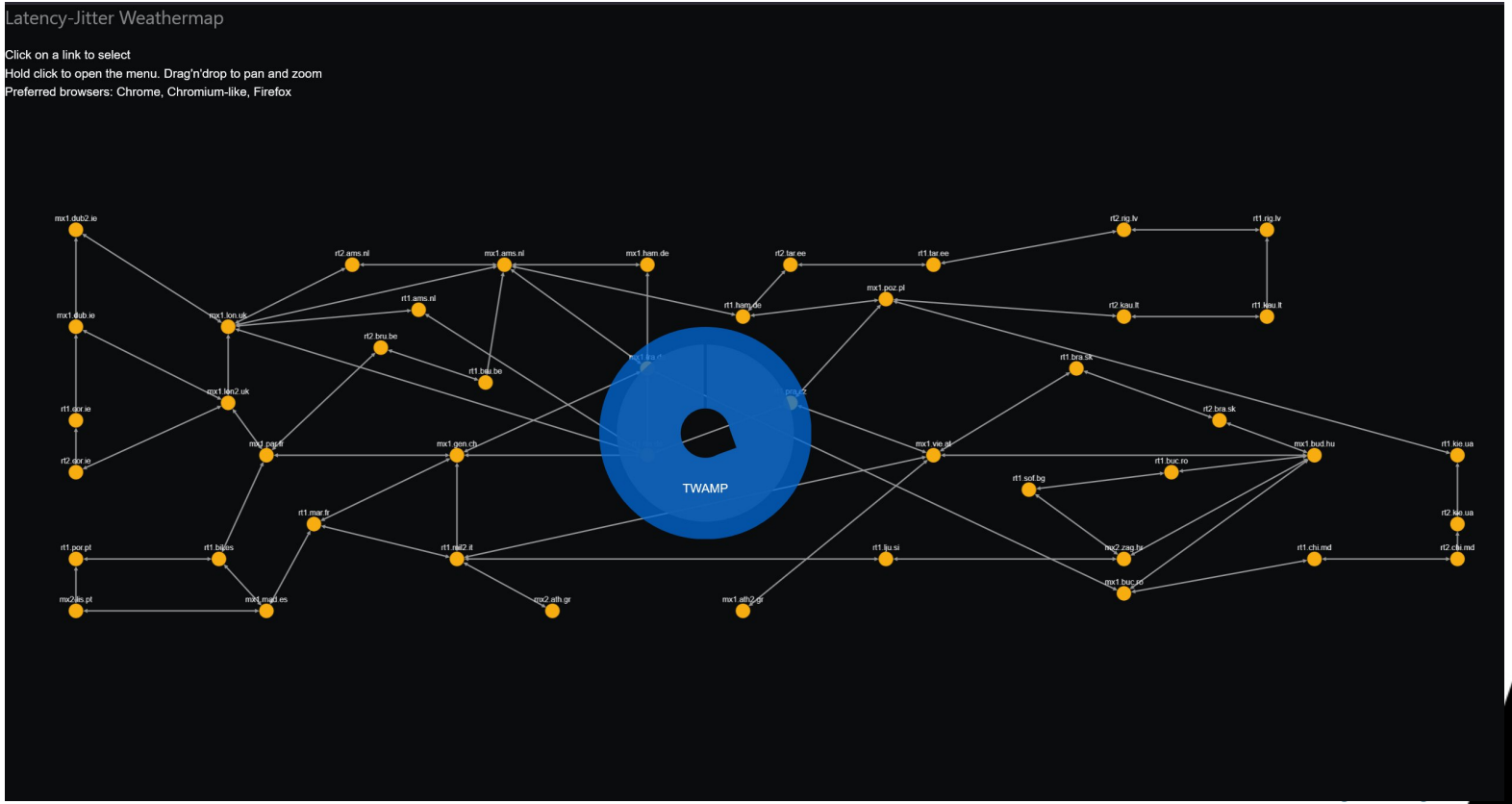
- The service on GEANT backbone

https://timemap.geant.org/

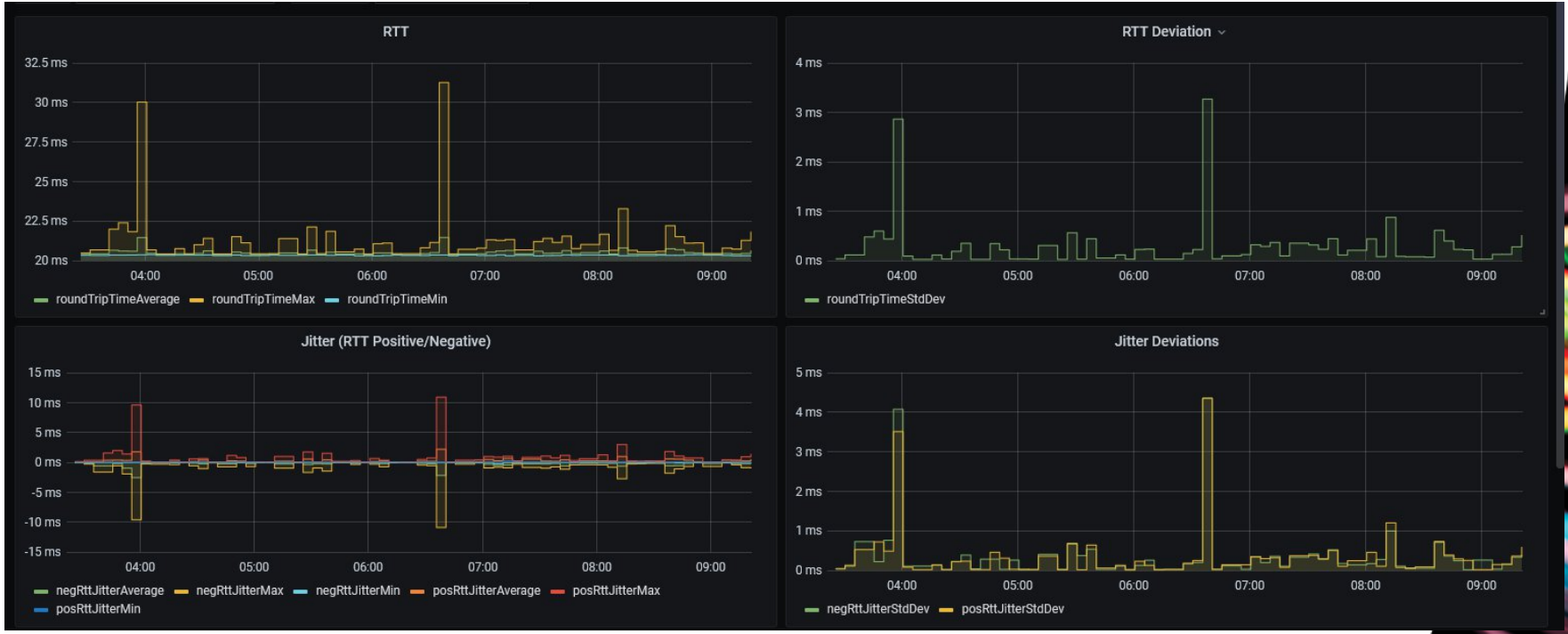
- Documentation: source code, user and admin guides, customization

https://gitlab.software.geant.org/gn4-3-wp6-t1-lola/timemap_public

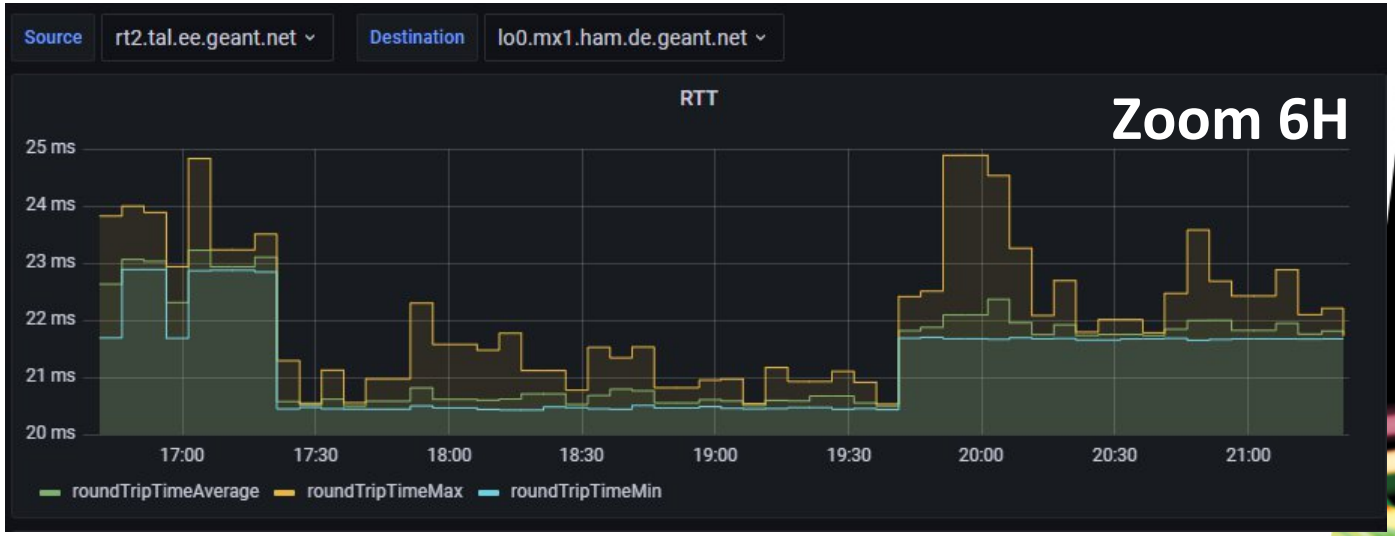
The entry map page: right-click on link



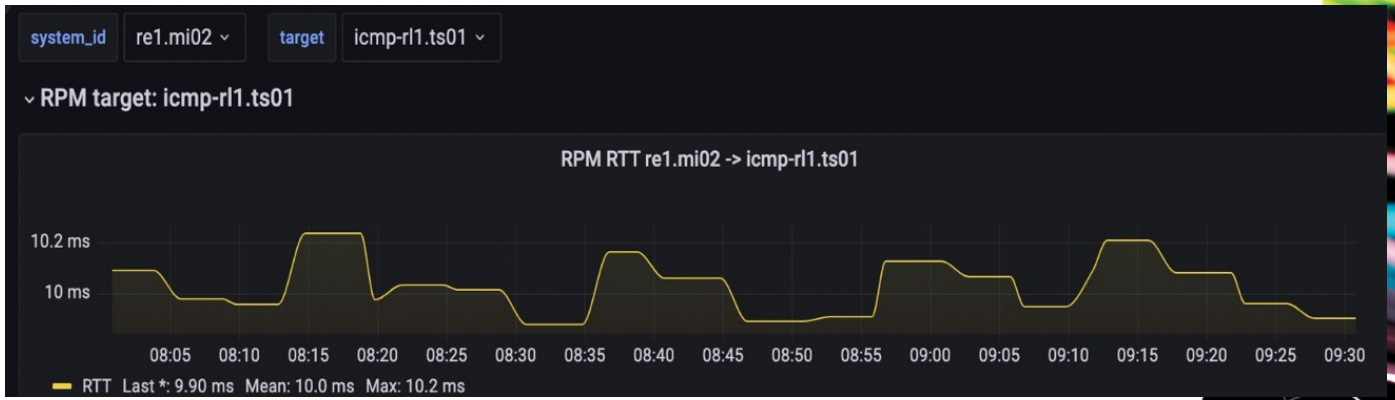
Observations



Re-routing

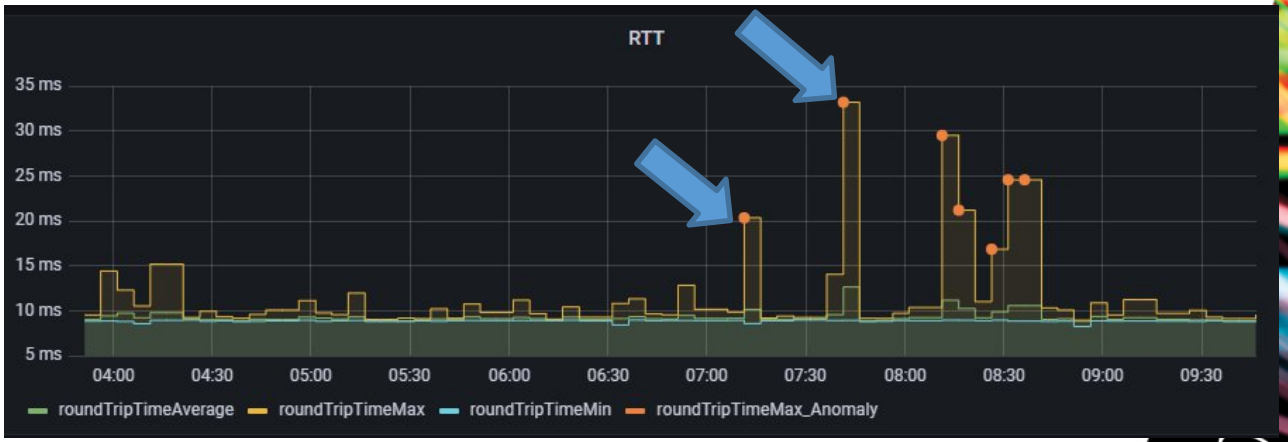


ECMP effects

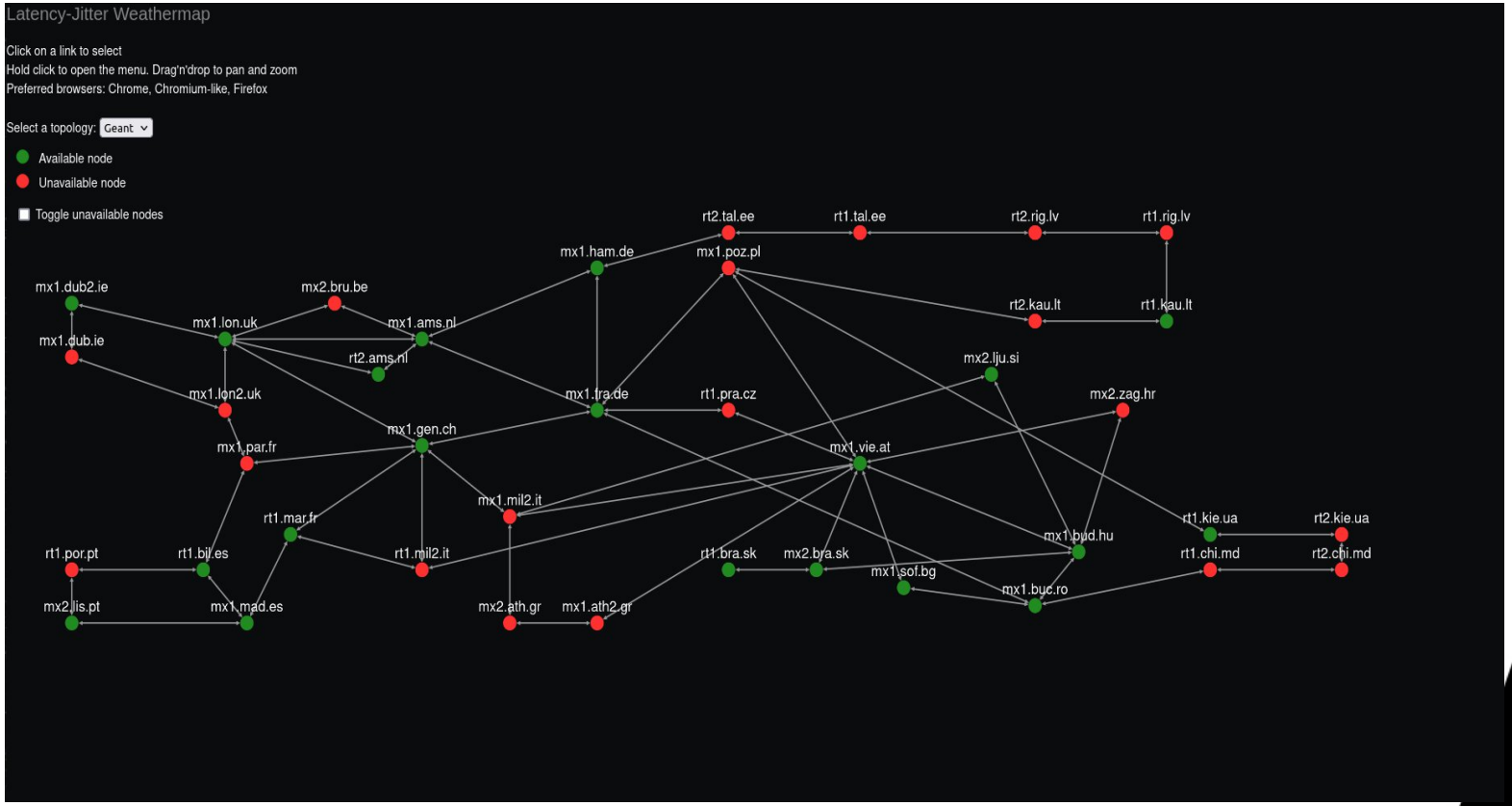


Trends (clocks shifting?)

Anomaly Detection in action



GUI enhancement to support new use-cases



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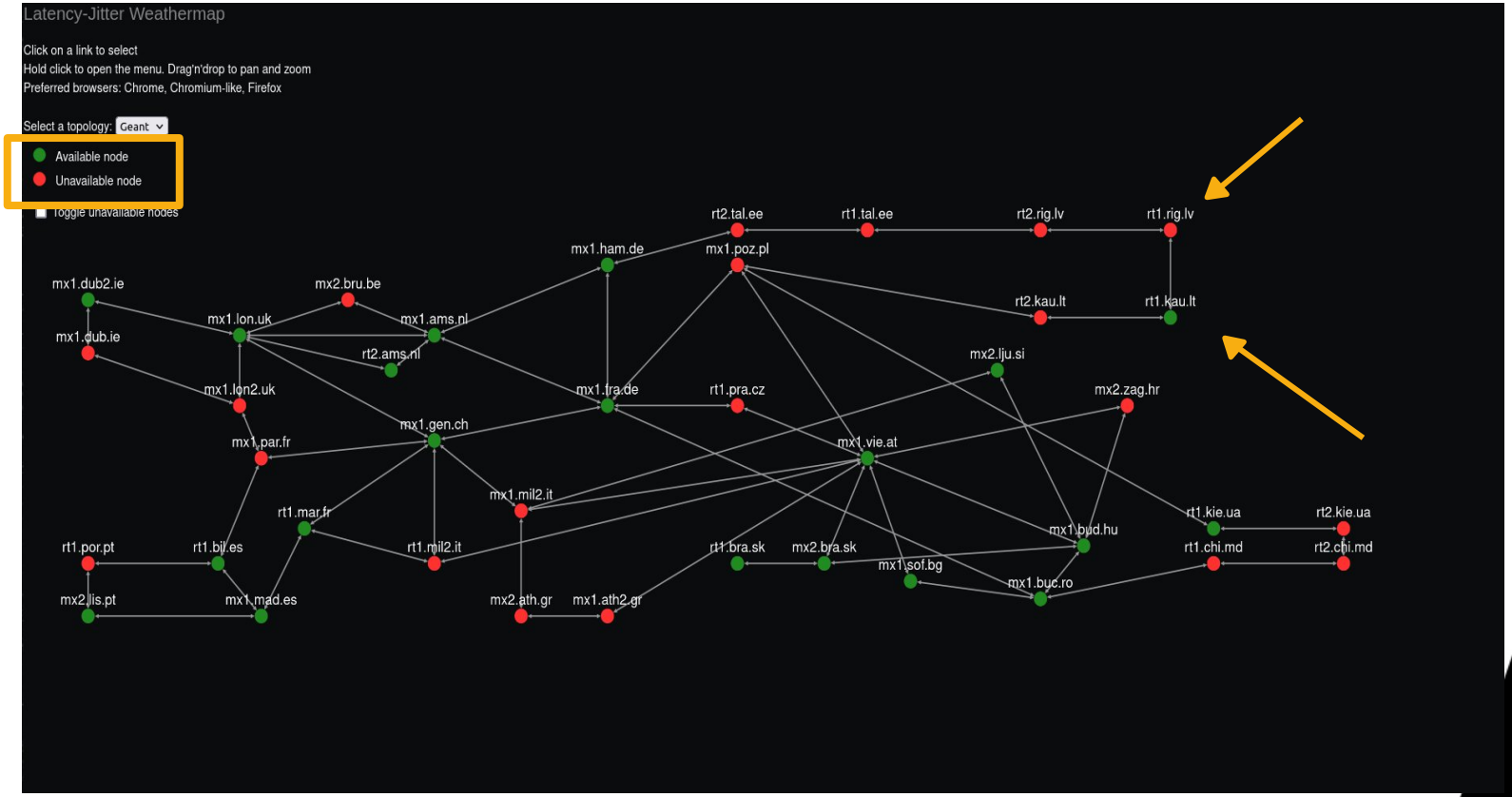
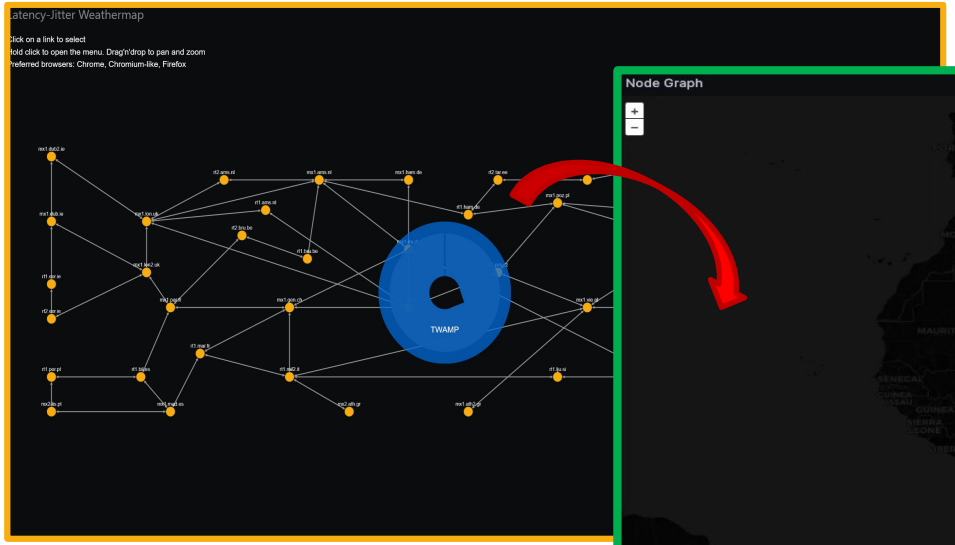


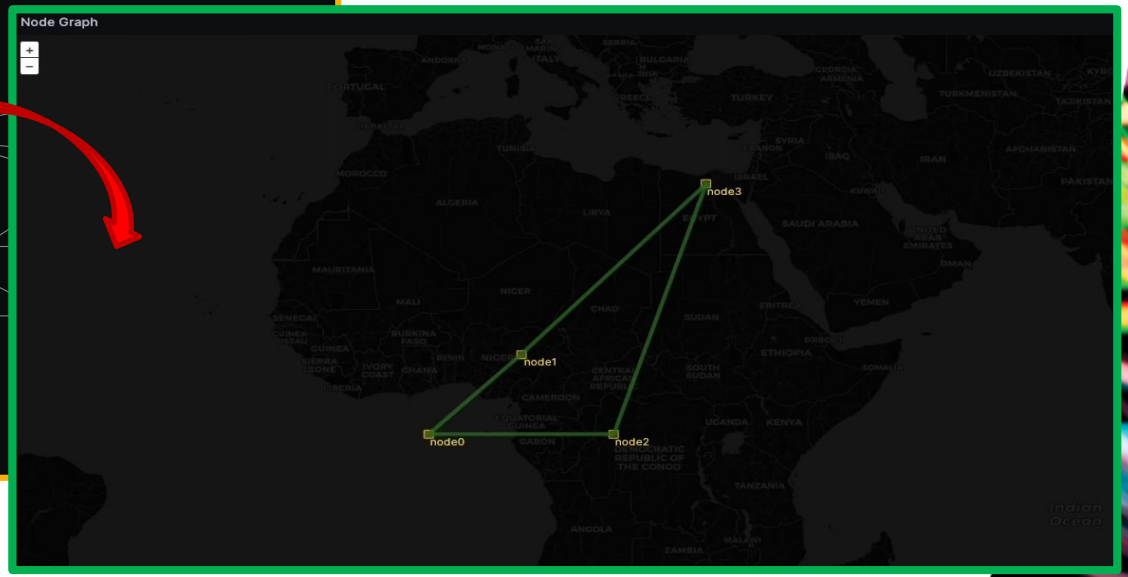
Future of the Graphic User Interface?

Keep improving our custom implementation?



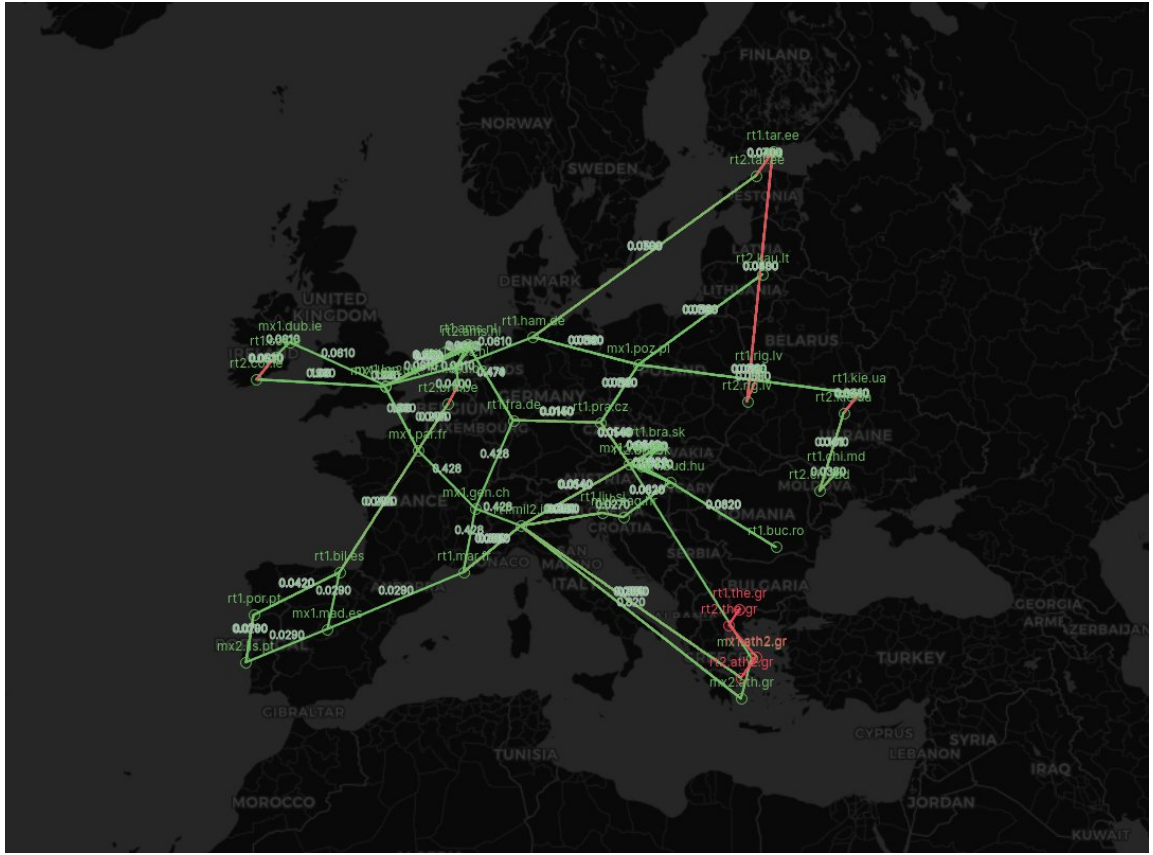
VS

Grafana Geomaps?



https://grafana.com/docs/grafana/latest/panels-visualizations/visualizations/geomap/#network-layer-beta

On-going – GeoMap visualization drawbacks

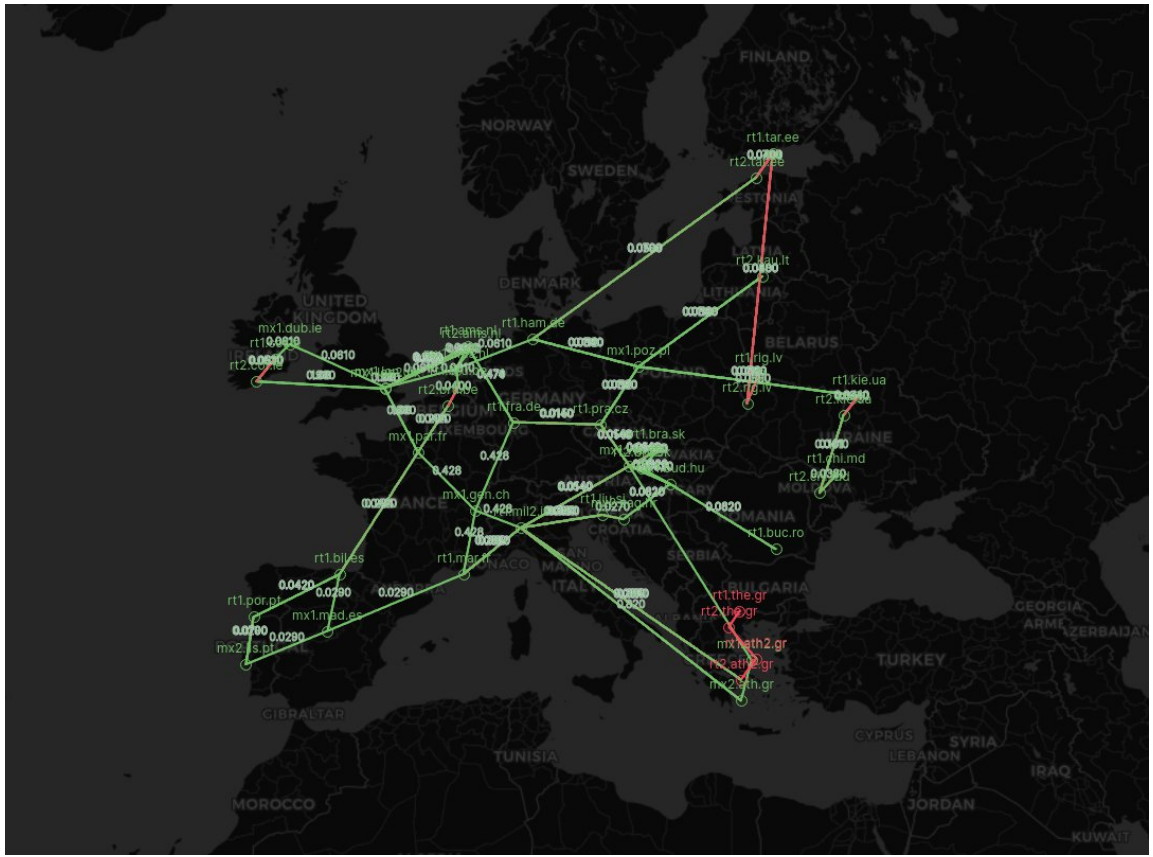


Pros:

- Topology overlay on **geographical map**
- **No** more **custom code**
- Dynamic **topology evolution**
- **Measurements** on display directly the on graph

https://grafana.com/docs/grafana/latest/panels-visualizations/visualizations/geomap/#network-layer-beta

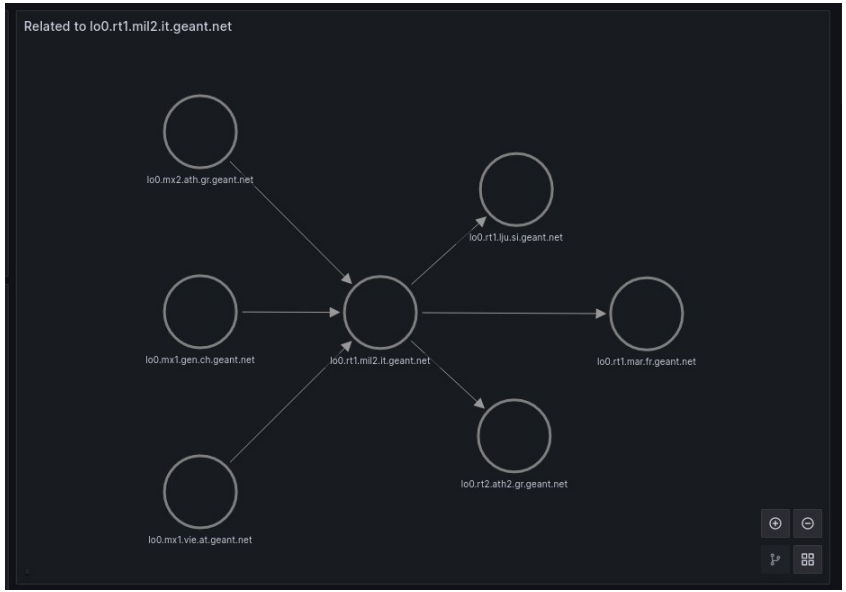
On-going – GeoMap visualization drawbacks



Cons:

- Data pipelines have to be compliant with Grafana inputs
- The Grafana network layer visualization is still in beta

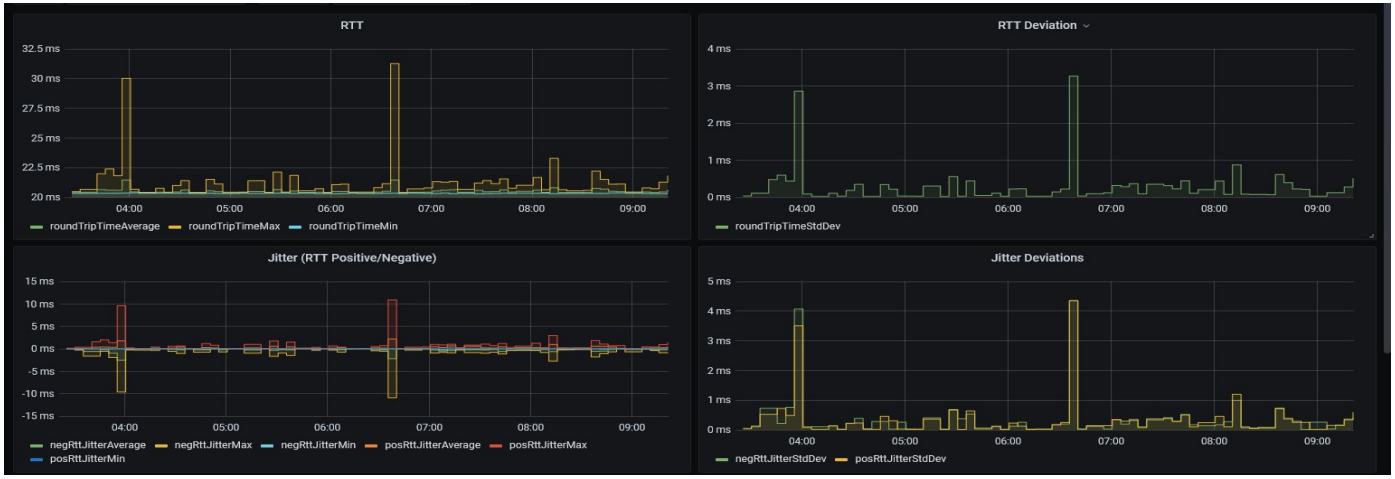
https://grafana.com/docs/grafana/latest/panels-visualizations/visualizations/geomap/#network-layer-beta



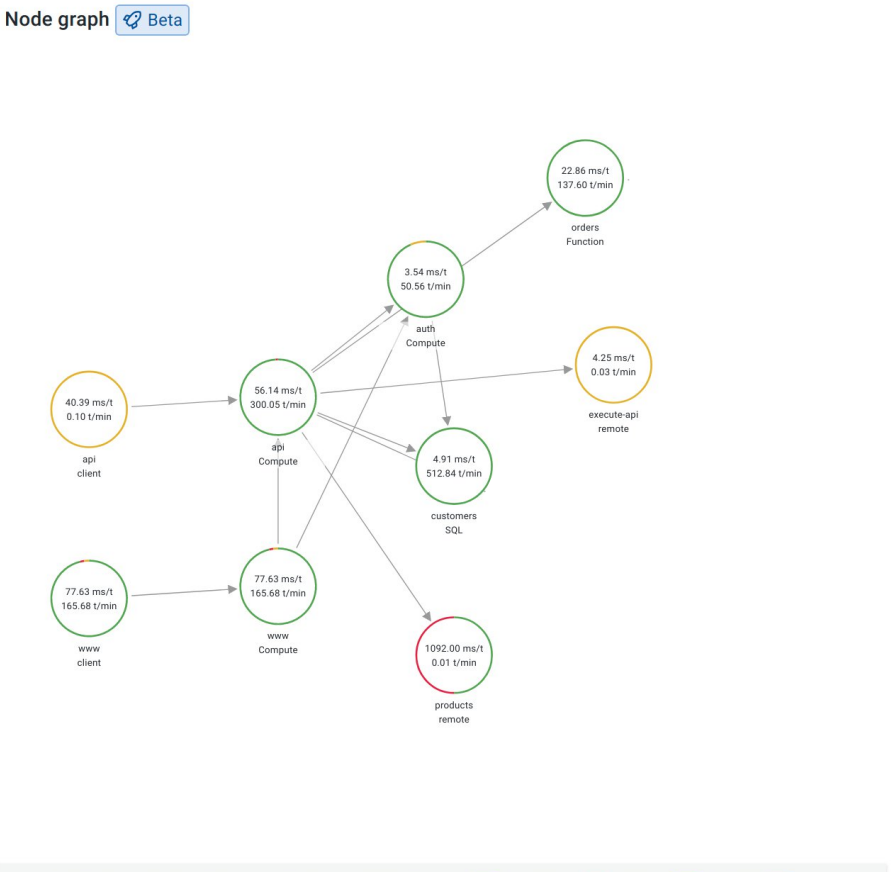
On-going - GUI with Grafana NodeGraph

In addition to the normal link measurements visualization

- Preview of the **dynamic** sub-graph on Milan



On-going - GUI with Grafana NodeGraph



- **Router sub-graph**

Maintains local spatial information about the topology also the detailed metrics dashboard

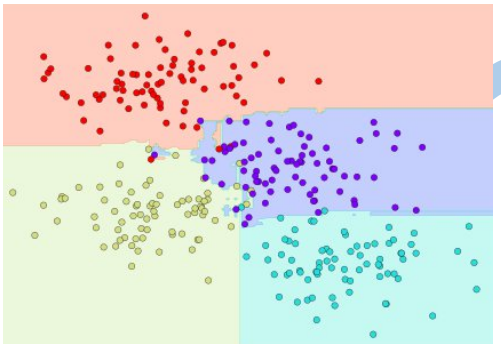
https://grafana.com/docs/grafana/latest/panels-visualizations/visualizations/node-graph/

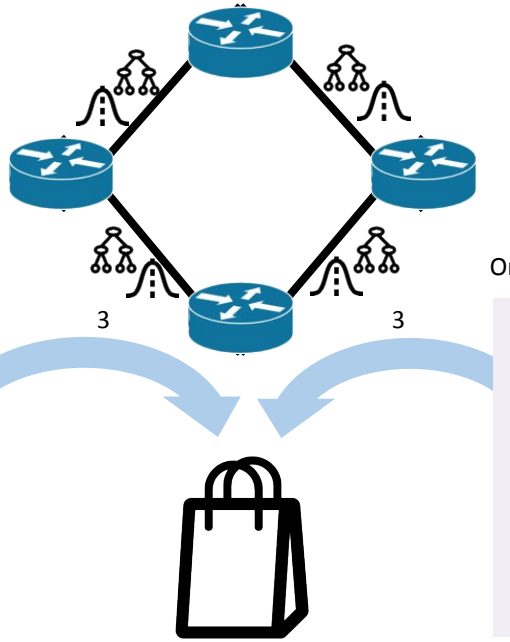
Anomaly Detection in Timemap – current toolset

- Anomaly Detection, in short
  - Std.Dev classification
  - Unsupervised
  - Sensible to overfit

- Streaming Machine Learning
- Light footprint
- Python https://riverml.xyz

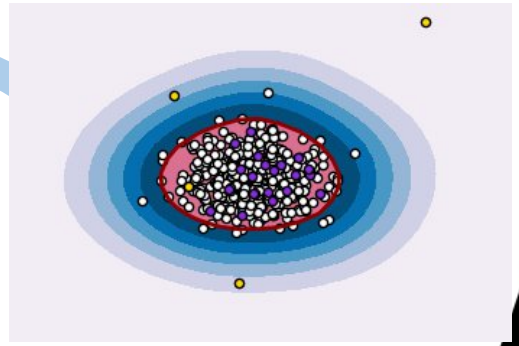
Half-space Random Trees





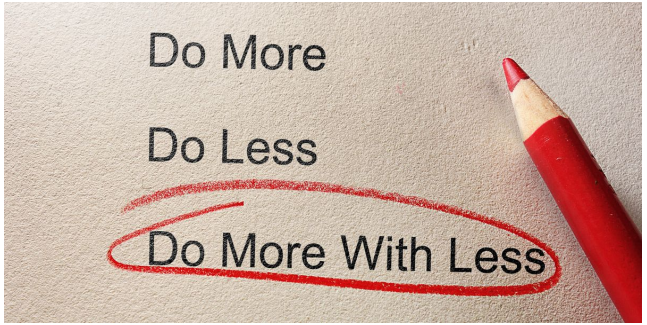
Model bagging

One-class Support Vector Machine



Improving TimeMap current data handling toolset

- Areas of improvement
  - Data handling
- Opportunities
  - Pandas data workflow

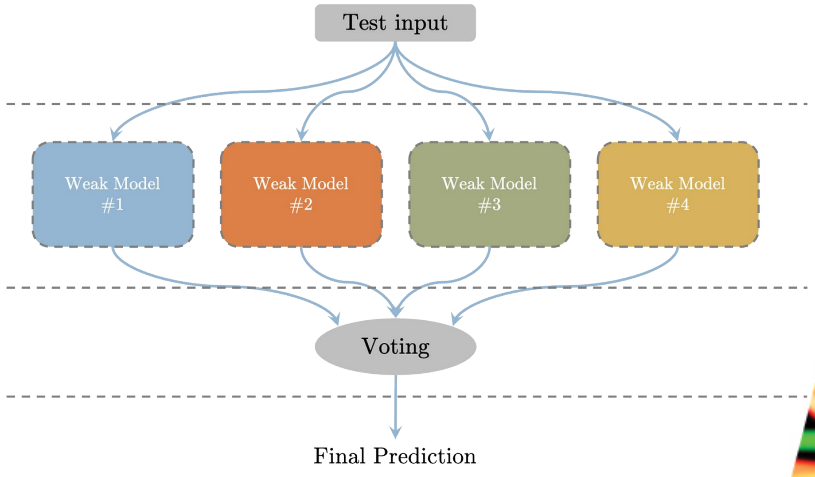


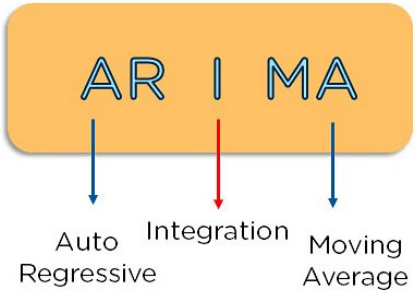
pandas

- Upsides:
  - Better readability
  - Less code, less effort

Improving Anomaly Detection in TimeMap

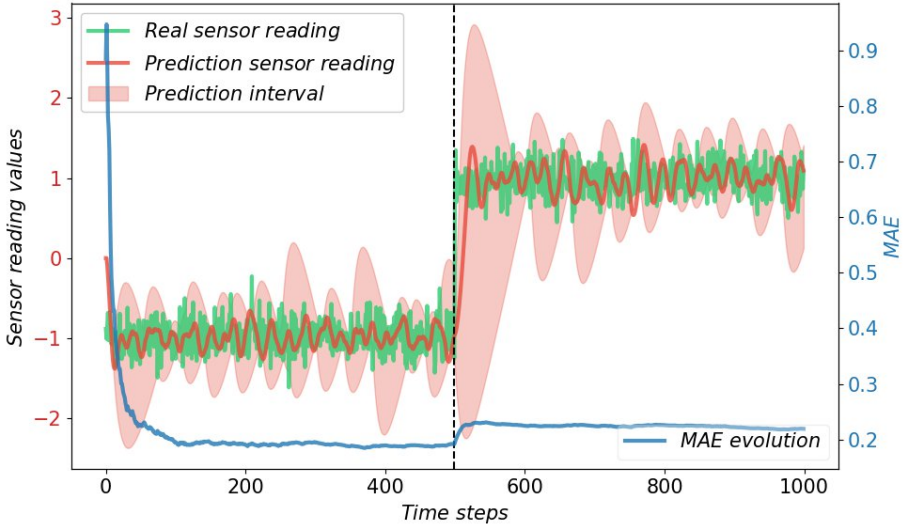
- Areas of improvement
  - Tackling overfitting
- Opportunities
  - Ensemble multiple models
  - Include generalized time series models





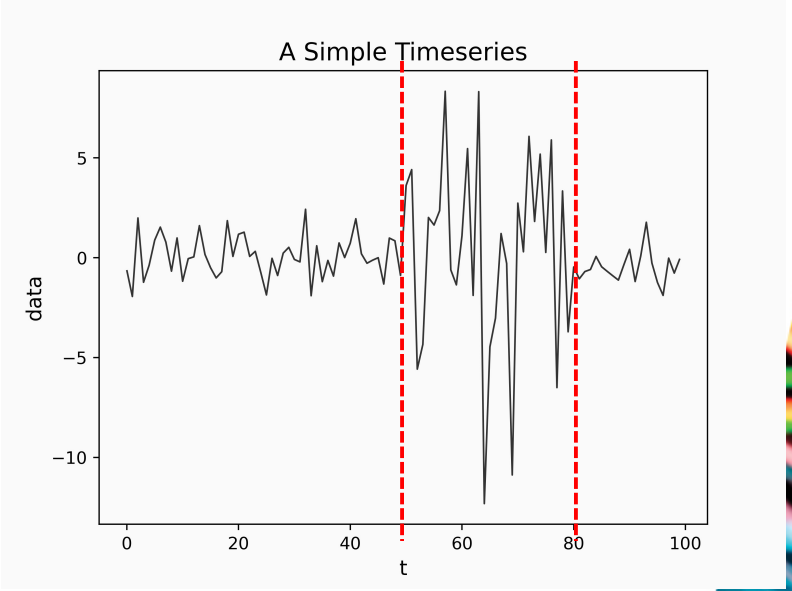
Improving Anomaly Detection in TimeMap

- Areas of improvement
  - Concept drift and data drift
- Opportunities
  - MLOps
    - Model retraining
    - Online learning
  - Model and data observability
    - Measure data distribution parameters
    - Measure model performance



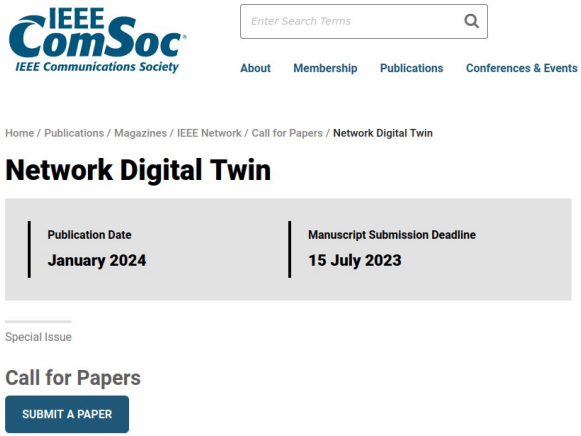
Improving Anomaly Detection in TimeMap

- Areas of improvement
  - Identification of anomaly end
- Opportunities
  - Time series changepoint detection
  - Python changepoint lib



Future of Anomaly Detection in TimeMap

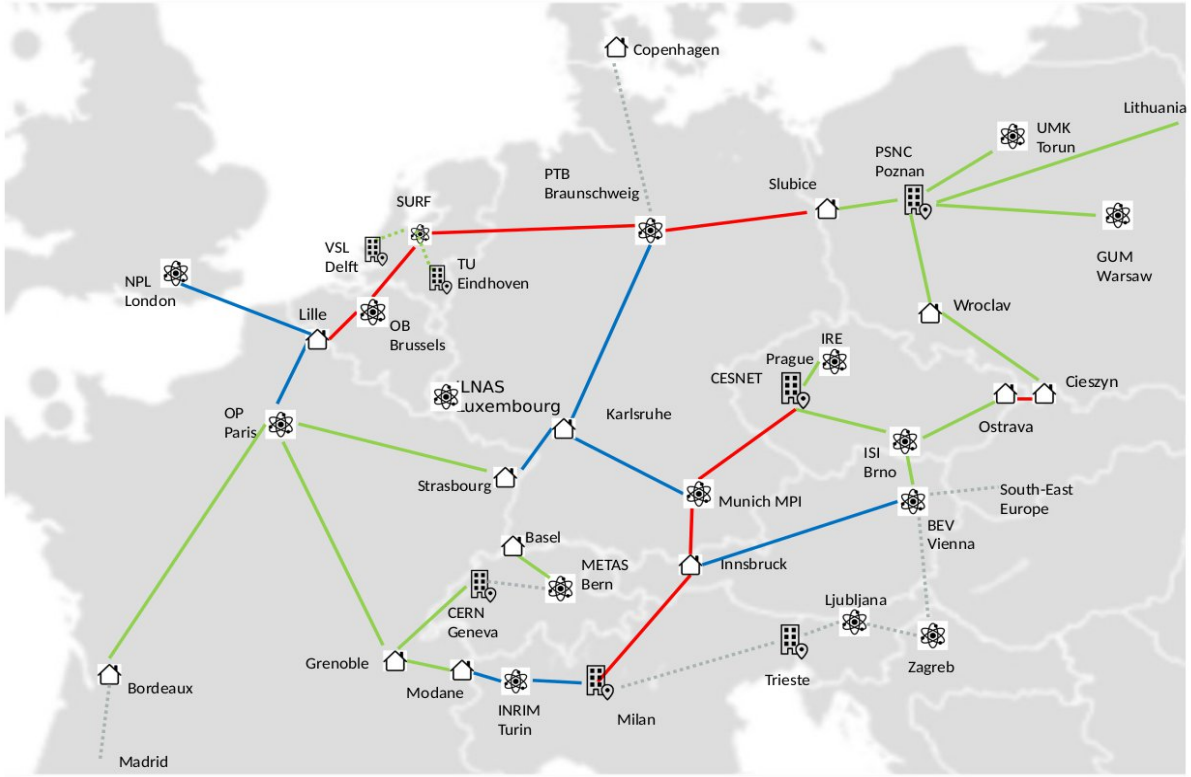
- Scouting novel deep learning approaches
  - Digital twin through Temporal Graph Neural Network



"Network digital twin aims at providing a virtual representation of a physical network system that is used to simulate various design scenarios, validate policies, and assess the behavior of the network system."

New TimeMap use cases: OTFN testbed monitoring

Proposed C-TFN



Included:

- 10-year IRU for fibre on red routes
- Bidirectional amplifiers as needed to light the fibre on the red routes

Excluded:

- Green lines – fibre built by NRENs
- Blue lines – fibre bult by NMIs
- Dashed grey – proposed future links
- flywheels, counters frequency combs needed are to be funded by the national time/frequency providers
- Time/Frequency overlay services

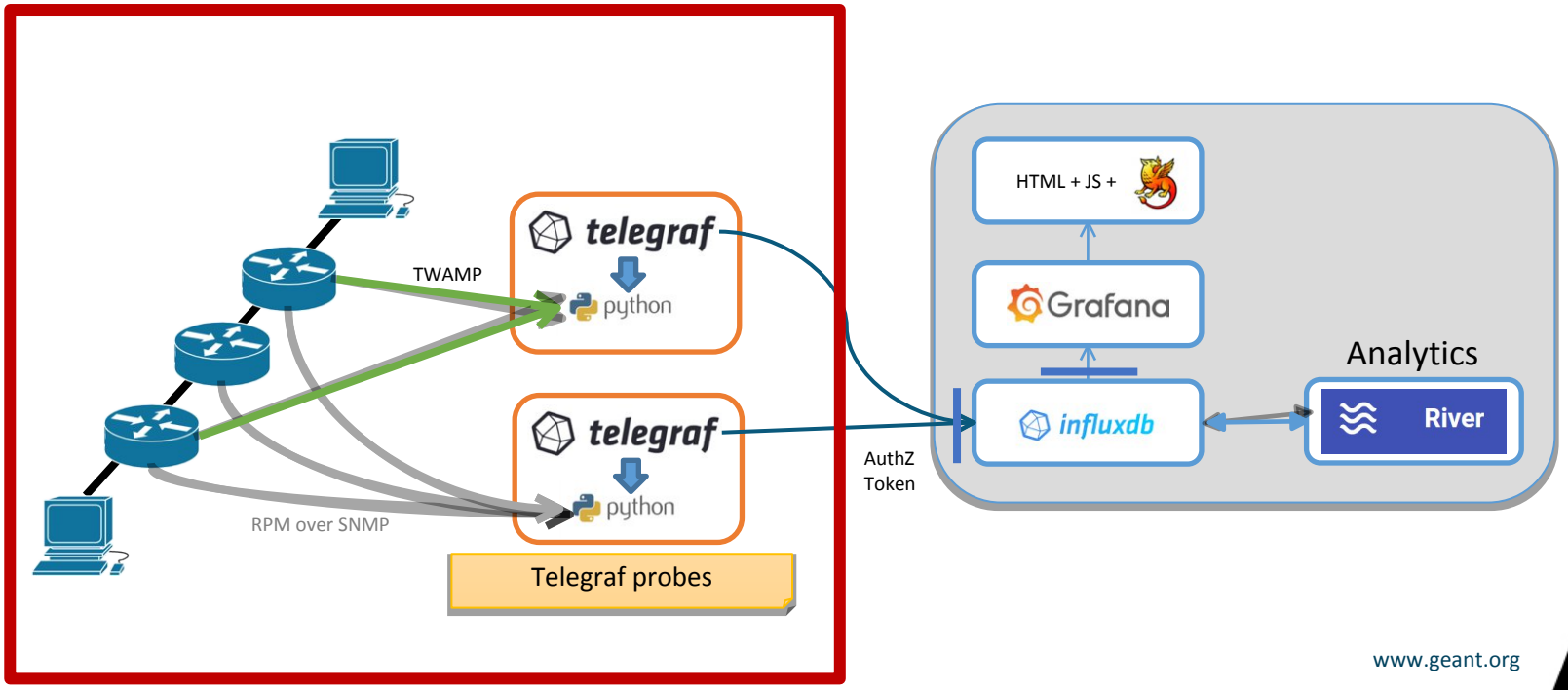
NMI Frequency reference

Research institute

Hut for housing RLS

How TimeMap architecture extends to multiple usecases:

New data probes for OTFN devices will plug seamlessly into the architecture



I want to deploy TimeMap to my network, how?

- Find the source code on:

https://gitlab.software.geant.org/gn4-3-wp6-t1-lola/timemap_public

- Deploy the observability stack
- Enable TWAMP on your network devices and set up your data probes
- Need some help? timemap-dev@lists.geant.org

Idea: TimeMap on LANs, any volunteers?

Conclusions

- TimeMap **continuous improvements**
  - Simpler code-base, less effort on technicalities
  - Focus on ML models and new use-cases

- TimeMap as a **solution to adopt and adapt**
  - Not just a service to consume
  - Different deployments built on top of the available code

- Next steps for Géant deployment
  - T/F pilot
  - Next generation Géant backbone routers

Thank you!

Questions?

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www.geant.org

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