Monitoring and Measurement in the Next generation Networks

Experimental infrastructure of Onelab2

Péter Hága
Eötvös Loránd University
Budapest, Hungary

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Why to build a new experimental facility?

- in the Internet it is often not possible to measure traffic flows and other aspects of usage
- the Experimental Facility should provide a platform with a rich set of tools for measurement and monitoring
- the EF should offer full observability of the experiment and the related data
- researcher can obtain data not visible in real life, due to administrative, implementation and privacy concerns

role of measurement

- models and analysis of measurement data plays a crucial role in the research on a Future Internet
- the design of new network architectures should be amenable to modeling and measurement in ways that today's Internet is not
- the research communities that are concerned with theory, analysis and modeling can benefit from the rich capture and logging of data from experiments
- privacy and rights of experimenters should be respected

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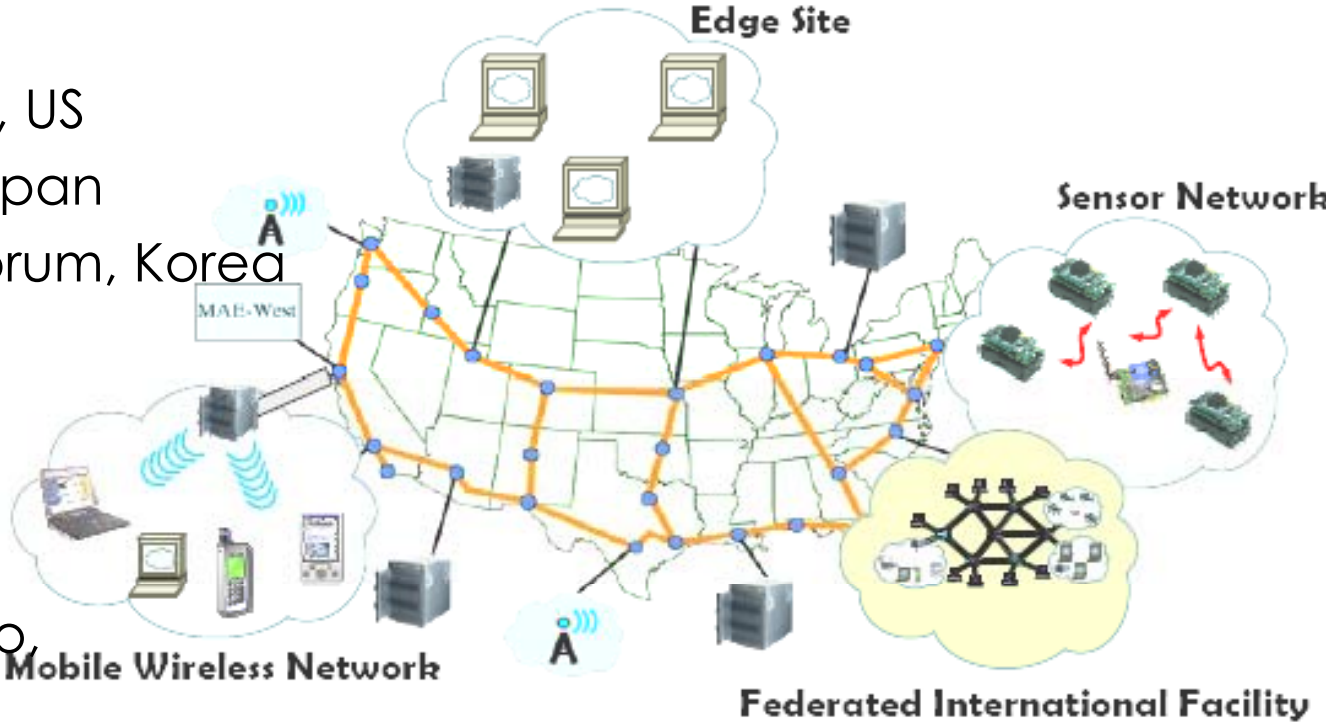
FI research initiatives

- GENI/FIND/NetSE, US
- AKARI Project, Japan
- Future Internet Forum, Korea
- ANR, France
- G-Lab Initiative, Germany
- SHOK, Fin
- Internet del Futuro, Spain
- EU Future Internet Research and Experimentation (FIRE)

GENI infrastructure



- OneLab2: An Open Federated Laboratory Supporting Network
- OneLab2 EU Integrated Project 2008-2010
- 29 participants Europe wide
- Budget 7.5 M€
- Aims to federate several infrastructures
- Includes building (extending) and maintaining a monitoring and measurement infrastructure (based on the Etomic)
- Partners involved:
  - Université Pierre et Marie Curie
  - Universidad Autonoma de Madrid
  - Tel Aviv University
  - Eötvös Loránd University

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etomic history

- The **E**uropean **T**raffic **O**bservatory **M**easurement **I**nfrastru**C**ture (etomic) was created in 2004-05 within the **Evergrow** Integrated Project.
- Since 2005 it is also supported by the Hungarian Office for Research and Technology (1M€/year)
- Its goals:
  - to provide open access, public testbed for researchers experimenting the Internet
  - to serve as a Virtual Observatory active measurement data on the European part of the Internet
- Serves as a pillar of OneLab2

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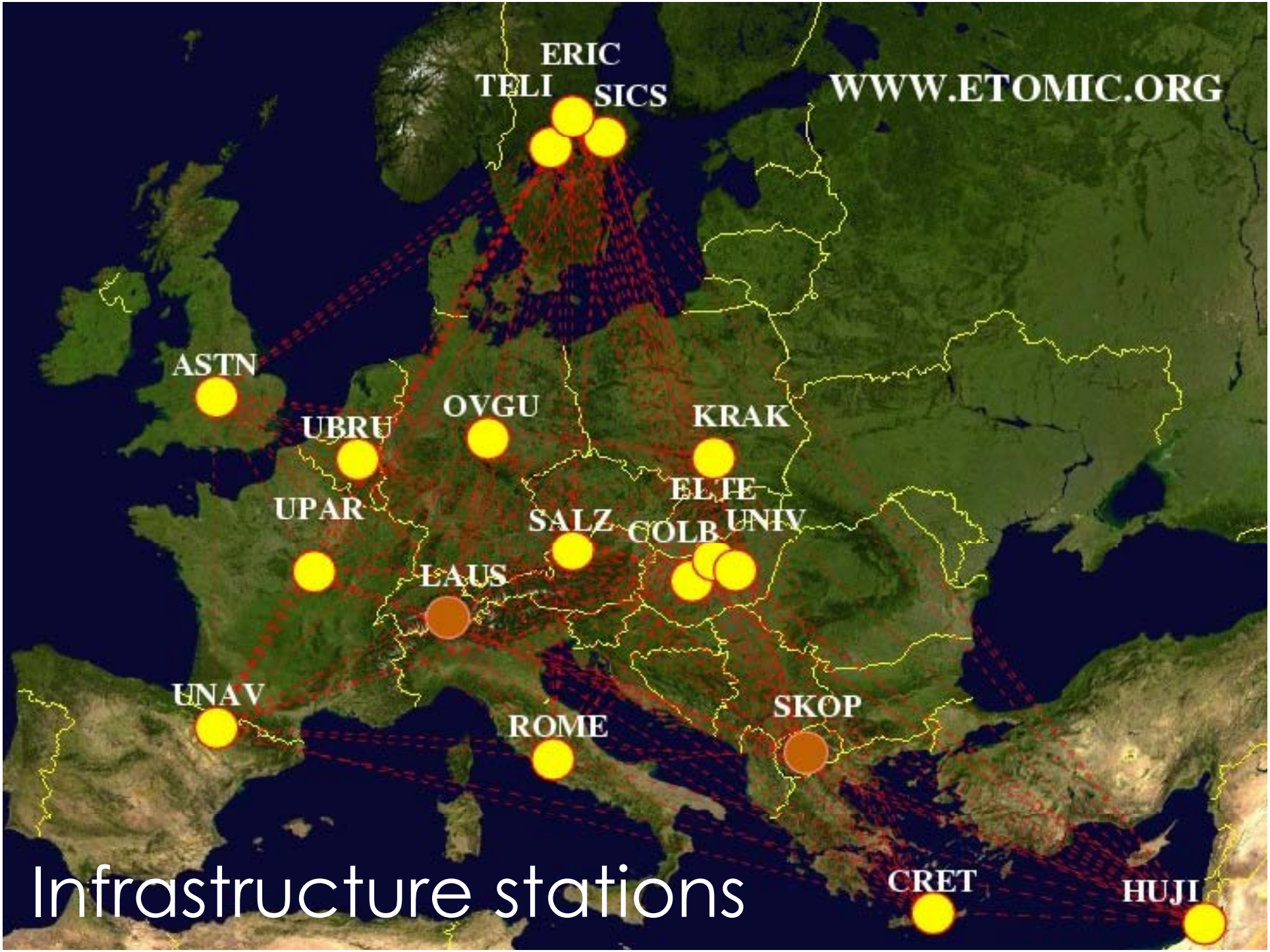
Founders

- Built by the Center for Communication Network Data Analysis (CNDA) and the Eötvös Loránd University.
- Central management system by Navarra University, Spain
- The measurement stations are hosted by:
  - European Universities participated in the Evergrow project
  - EuroLab members
  - MoMe members
  - associate partners of CNDA



Infrastructure stations

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The GENI connection

GENI Component Reference Design ***3 November 2006 (Version 0.76)***

As an example, the GENI edge server components can incorporate an *optional* network instrumentation element (e.g., Endace DAG 1GigE card). This type of hardware -- already in use by the ETOMIC subproject of the EU's EVERGROW Integrated project -- would let researchers carry out network measurements between geographically distributed sites with high temporal resolution (~10 nanoseconds) that is globally synchronized. It would provide GENI with a high resolution, spatially extended dynamic picture of fast changes in network traffic, thereby open up new kinds of network tomography.

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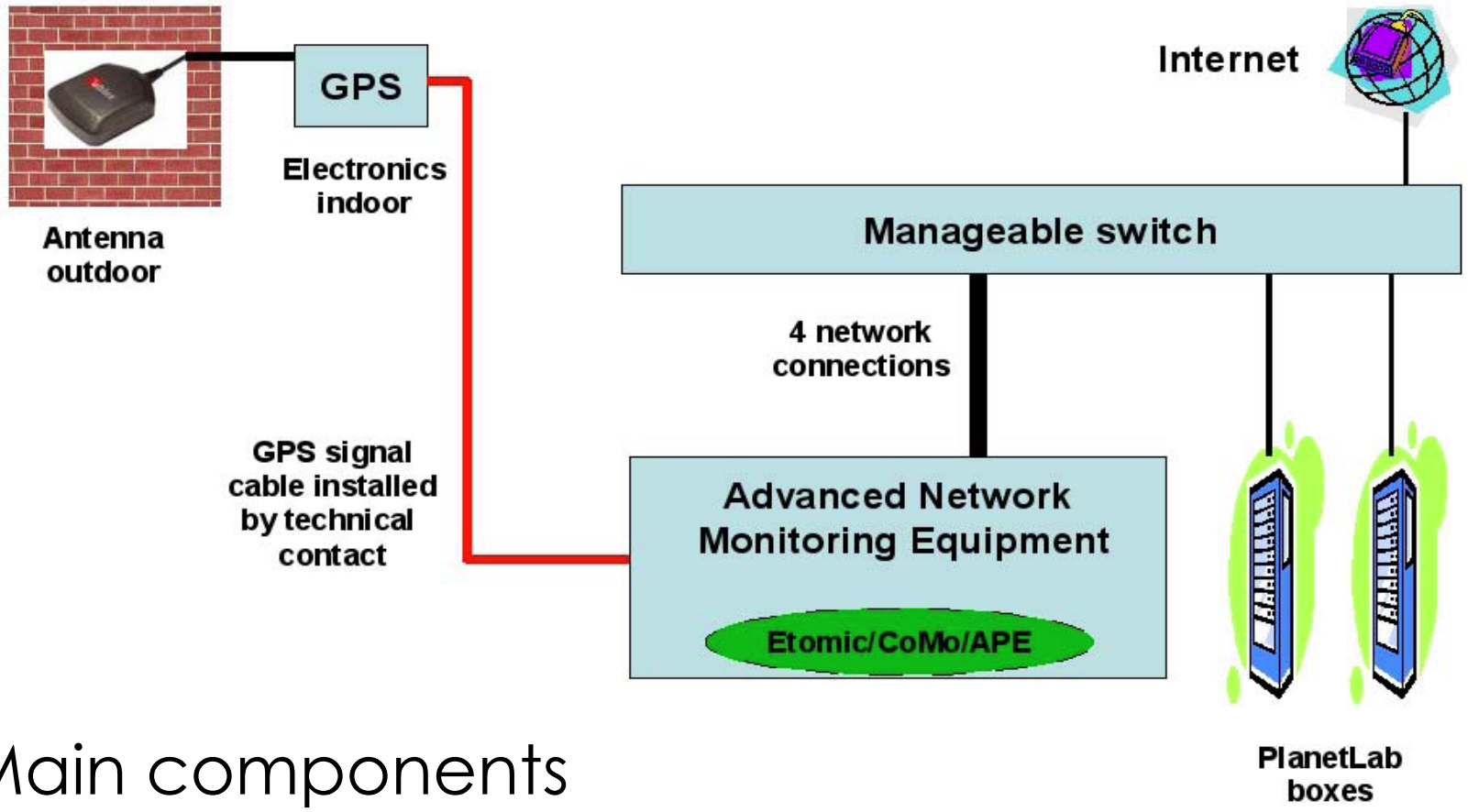
OneLab
FUTURE INTERNET TEST BEDS



Main components

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ANME features

- Web interface available via www.etomic.org
  - Account application -> own measurement design
  - Free access to periodic measurement end-to-end data
- Measurement time slot reservation for registered users, unique slot (experiment are not affected by other users)
- Programming DAG and ARGOS cards via a user friendly API
- Controlling APE box
- Fully configurable active measurement scenarios
- Measurements are distributed automatically to the measurement stations
- Measurement data is stored in a VO fashion

Onelab – Advanced Network Monitoring Equipment (ANME)

Hardware setup

ANME hardware components

- Etomic
  - Precise active measurements with DAG 3.6GE and ARGOS FPGA
- CoMo
  - Monitoring the traffic of Planetlab nodes
- APE
  - lightweight measurement box
  - standalone
- GPS receiver to provide time synchronization

Etomic/CoMo architecture

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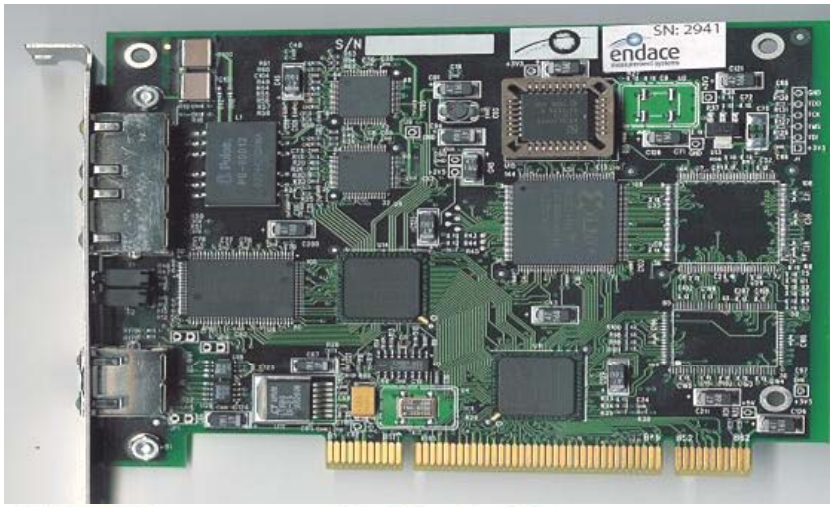
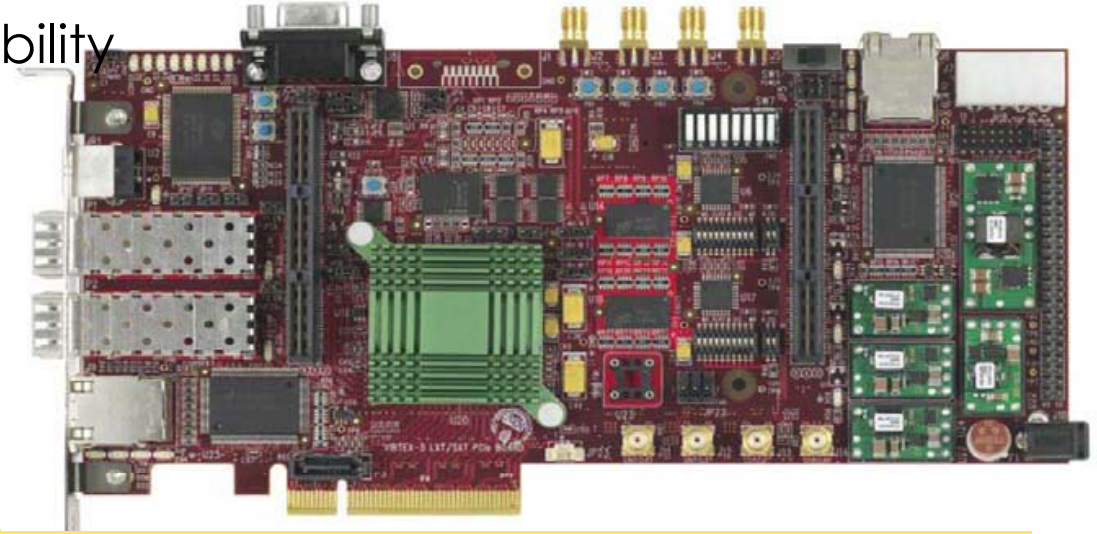
- Server PC architecture
- Linux OS
- Endace DAG 3.6 GE card
  or
- ARGOS FPGA measurement card
- with packet sending capability
  (packet offset ~60ns)
- own GPS antenna for
  time synchronization





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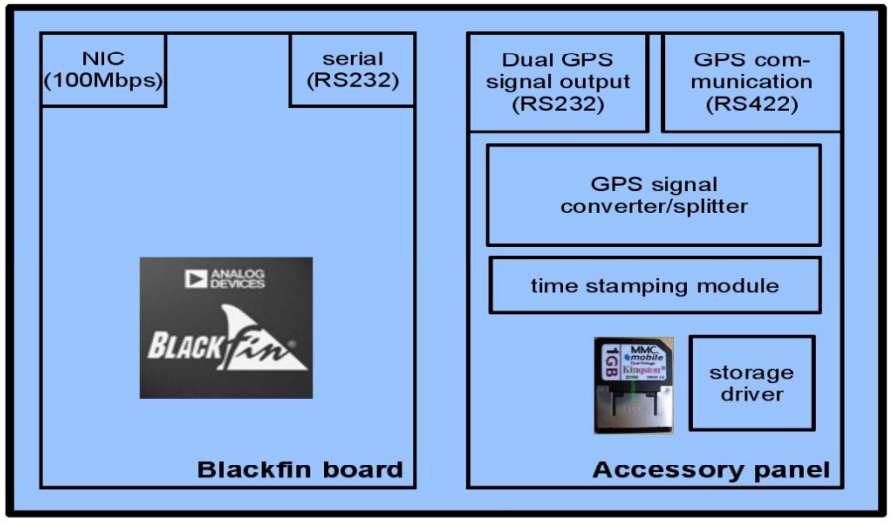
APE lightweight measurement box

- low cost (300 €)
- standalone
- based on Blackfin programmable board



etomic Central Management System

Infrastructure management

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Central Management System

- Etomic CMS
- IBM blade server
- User management
- Node maintenance
- Experiment scheduling
- Storing experiment results (temporally)
- Web GUI

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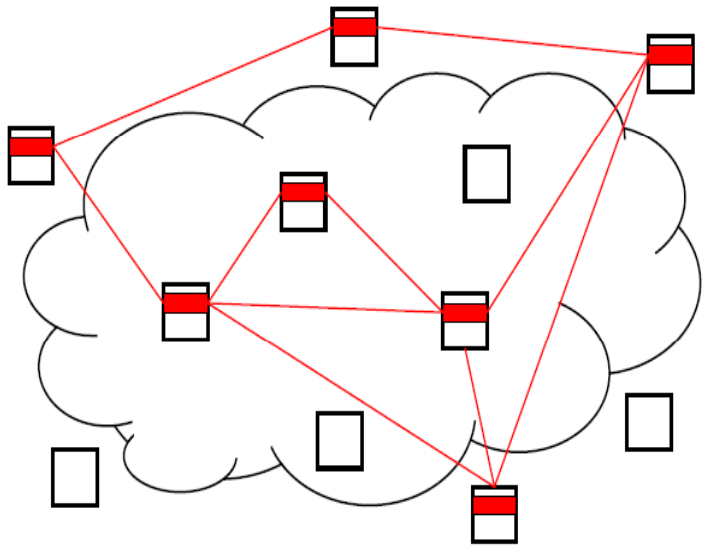
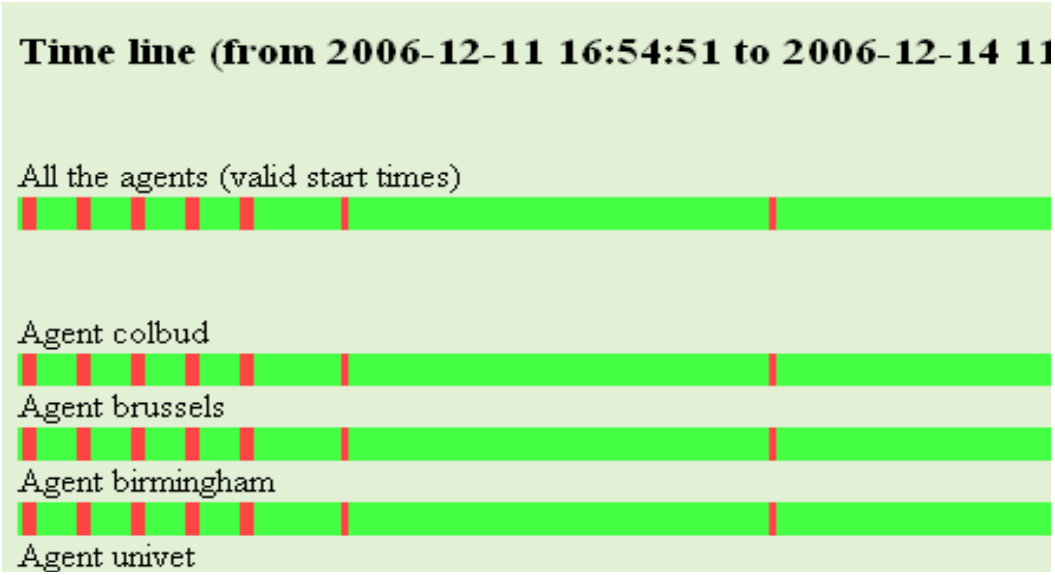
Slices vs. unique timeslots no virtualization

- balancing sliceability and fidelity is one of the most fundamental challenges facing the EF
- virtualization allows many researchers to share a common set of resources
- while virtualization introduces too much unpredictability in timing measurements
- dedicated measurement hardware elements can be allocated to some slices. Measurement hardware should operate under temporal *partitioning principle.*





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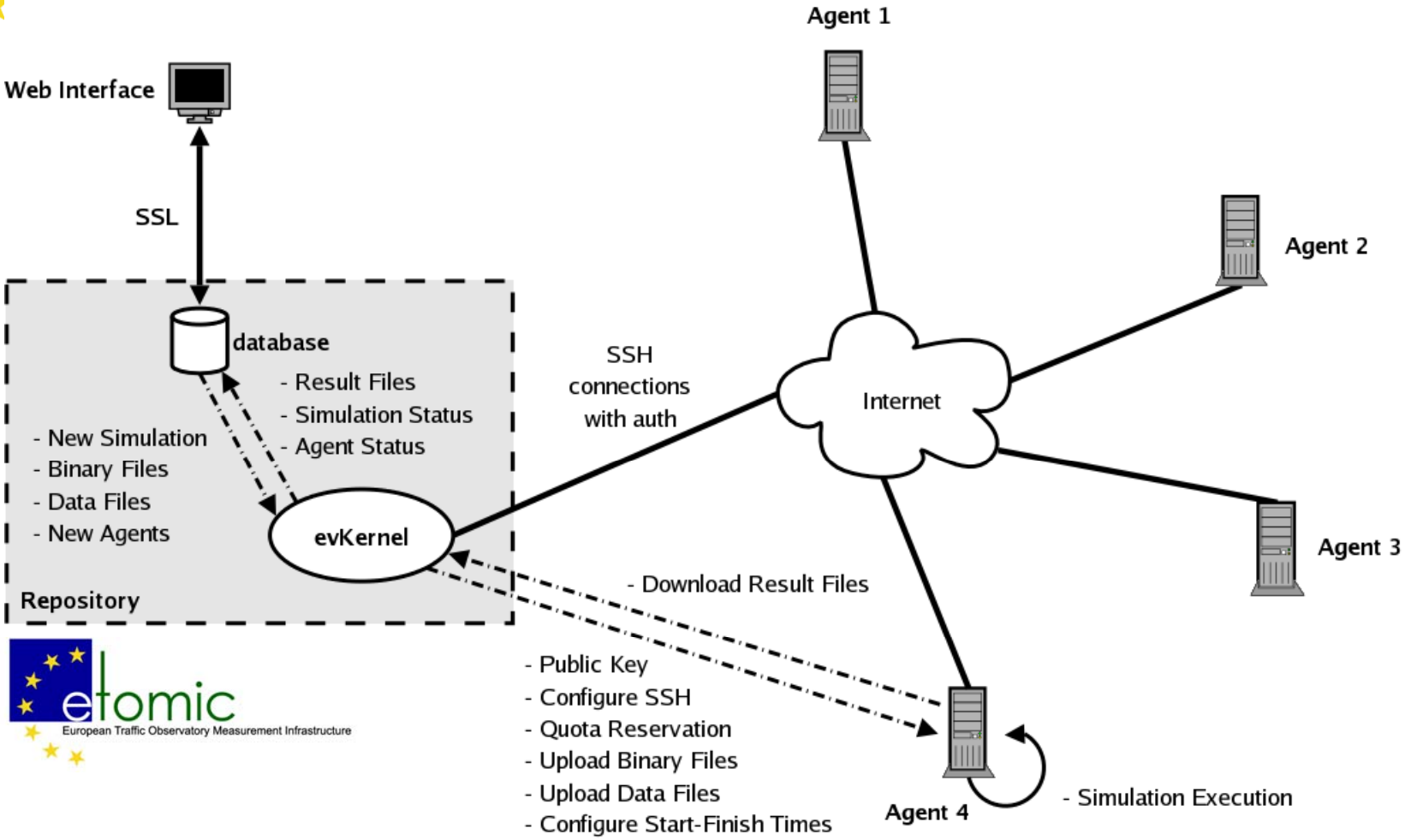
realization

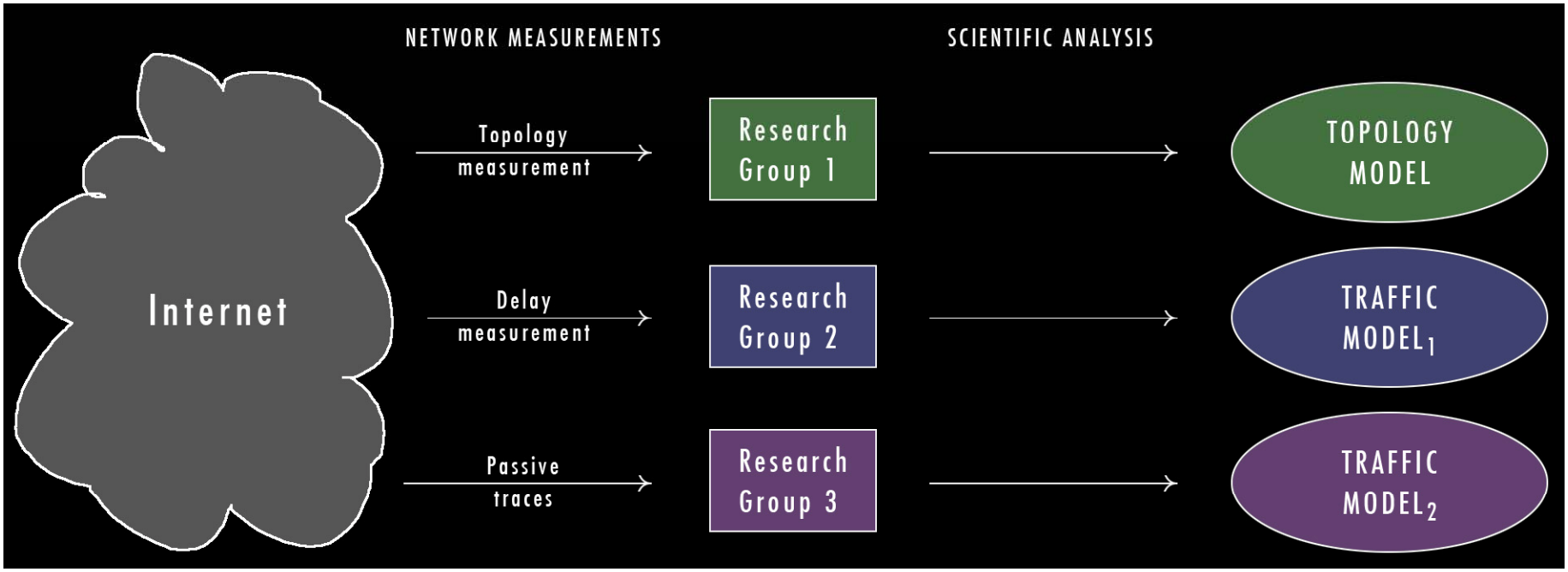


Store & share

Data handling

Traditional approach

- Traditionally measurements are designed to collect only specific data, important from the point of view of the researcher's agenda



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VO approach

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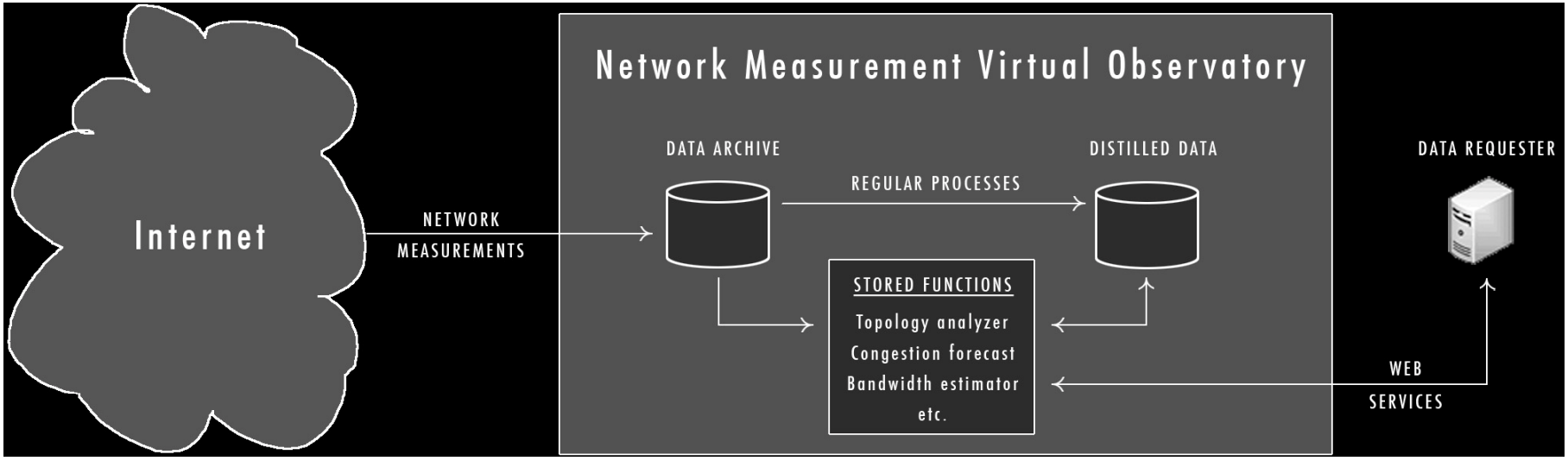
- The modern approach is to collect and store all measurable data and make it available for „virtual observation”. Virtual measurements can have set of goals different from the original



Casjobs - database interface

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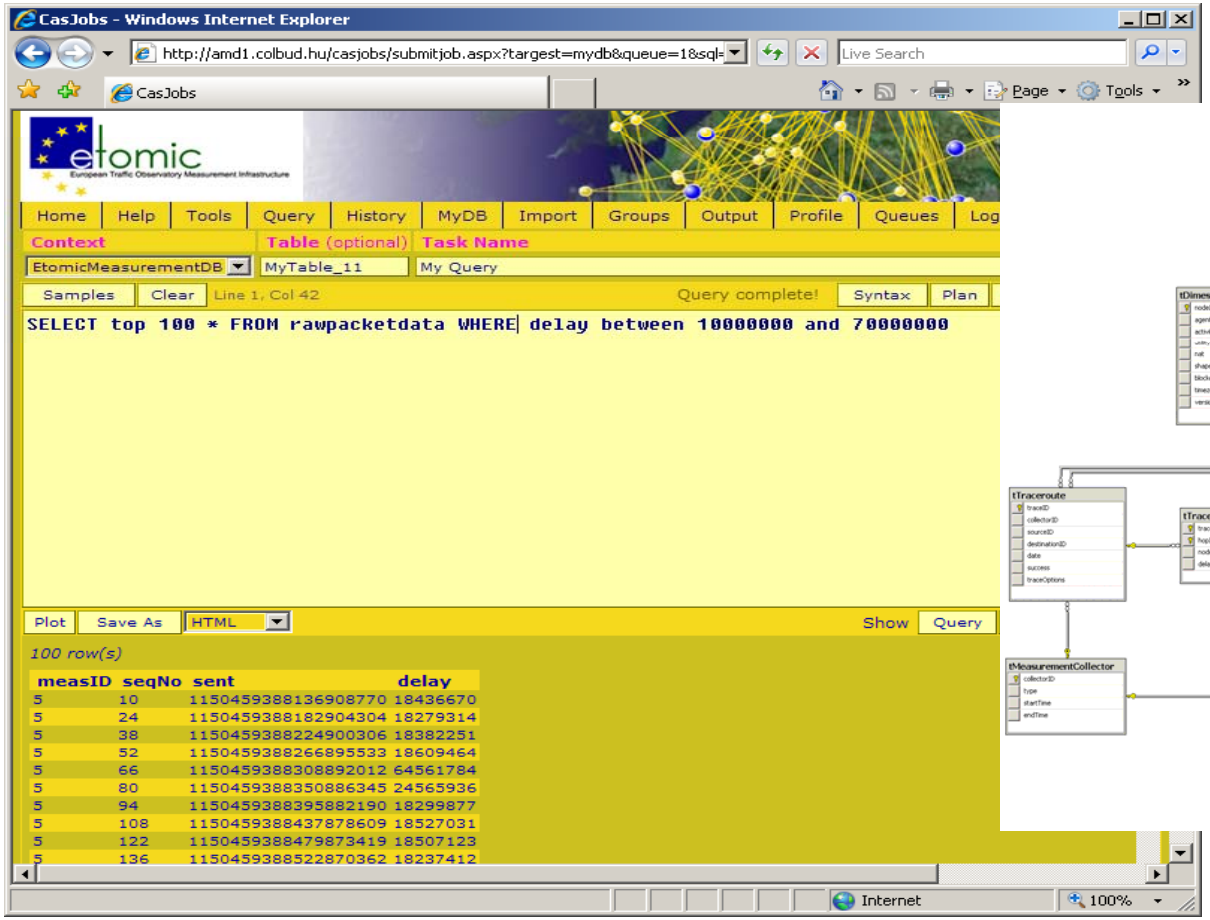

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Unified interface

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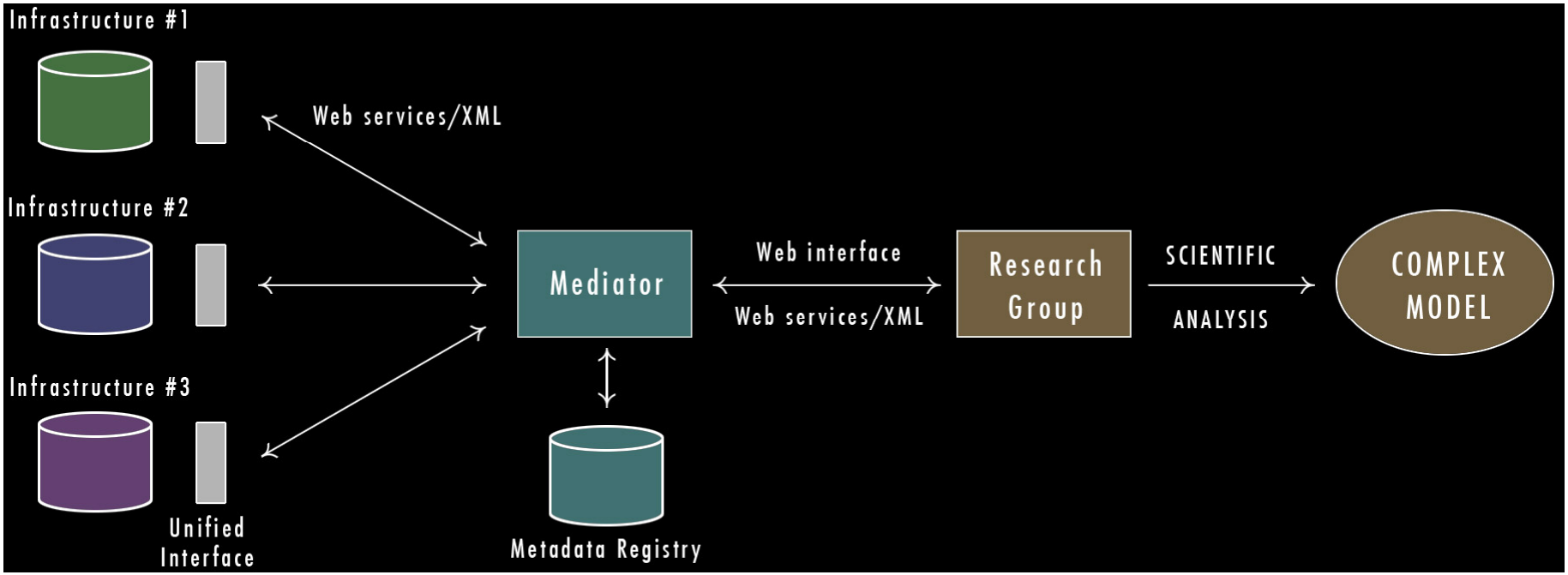
- VO can be realized by collecting measurement data from different infrastructures. Data structures should be standardized → netXML



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Key ideas

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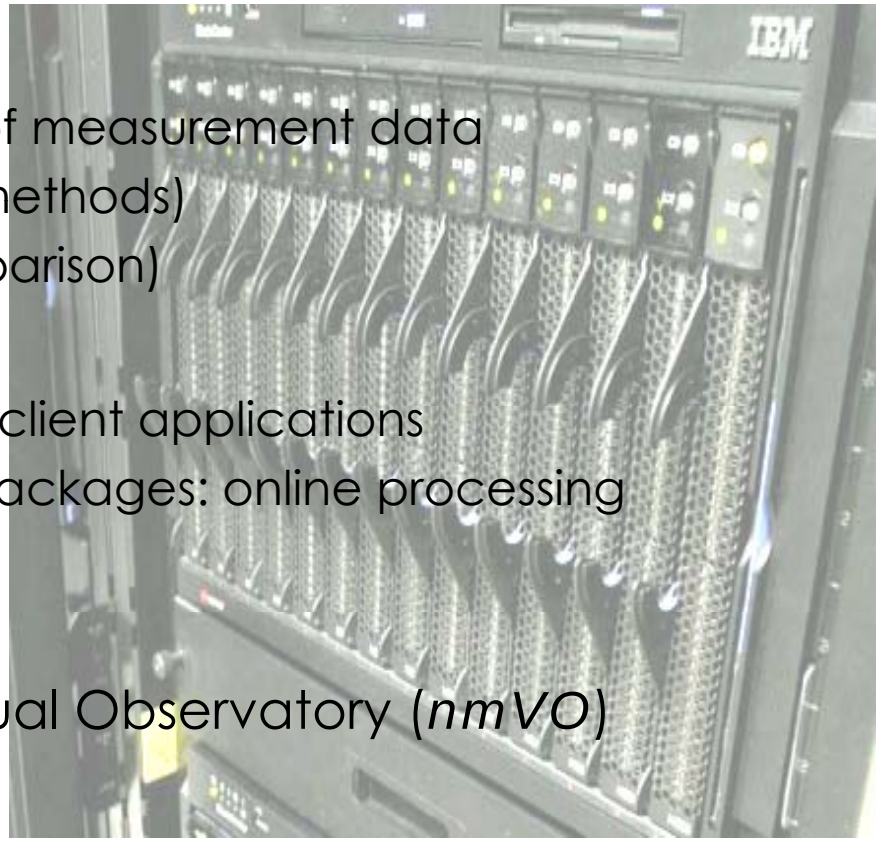
- store & share raw data
  - joint analysis of different types of measurement data
  - reanalysis (with new statistical methods)
  - reference data (historical comparison)
- share analysis tools
  - server side processing simplifies client applications
  - no need to transfer bulk data packages: online processing
- Standardization, network XML



Network Measurement Virtual Observatory (*nmVO*)

Some ongoing topics

Experimental use cases

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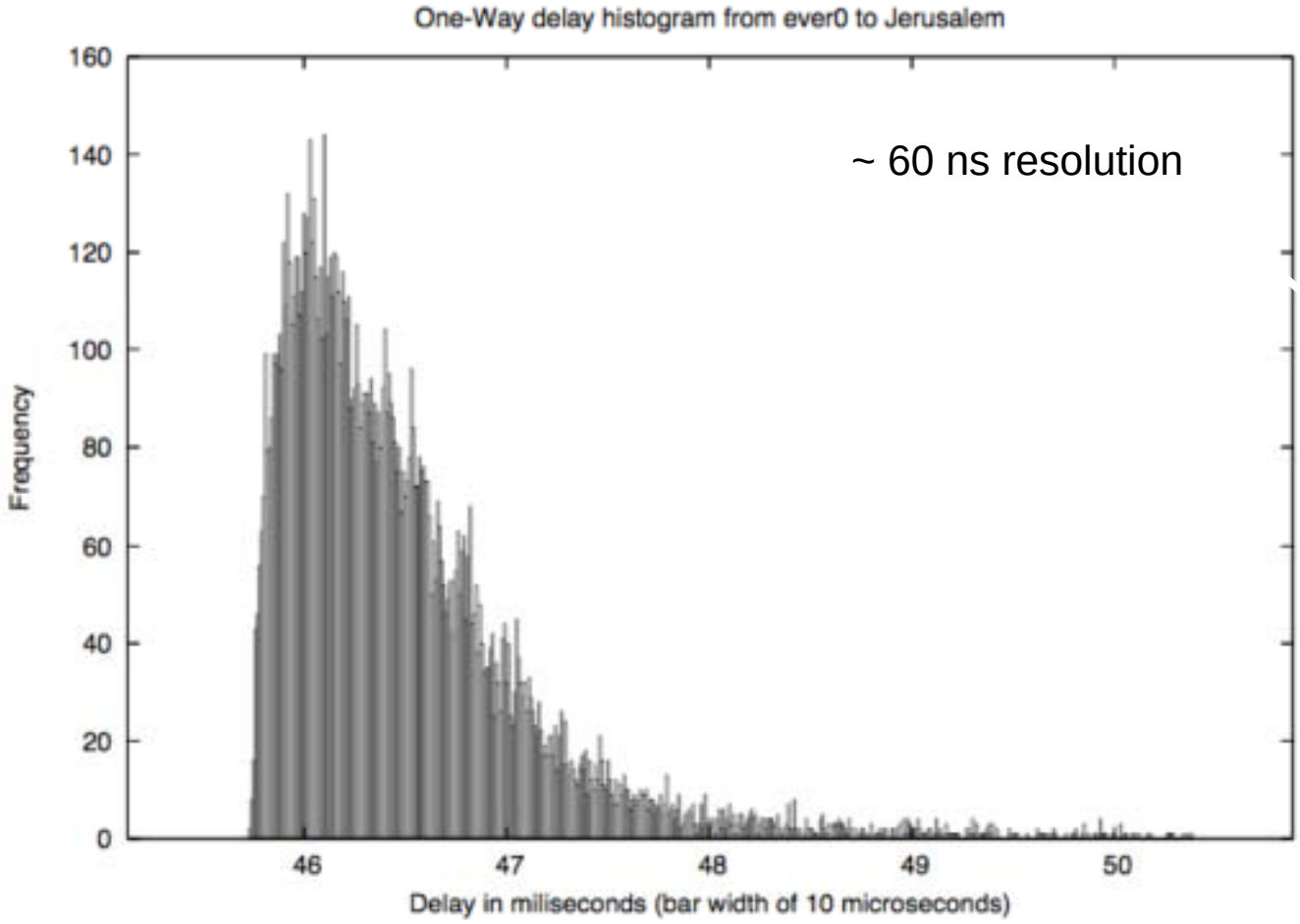
One way delay



~ 60 ns resolution

GPS visibility information

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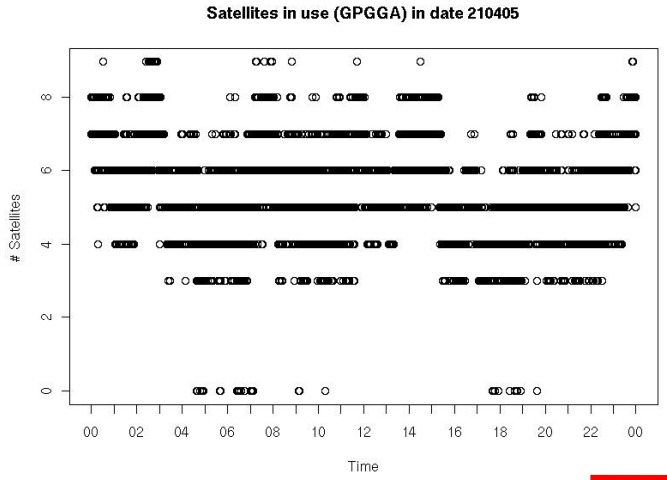
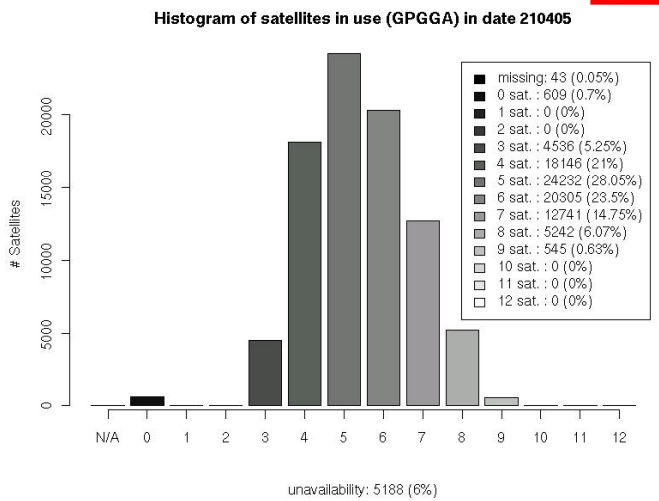
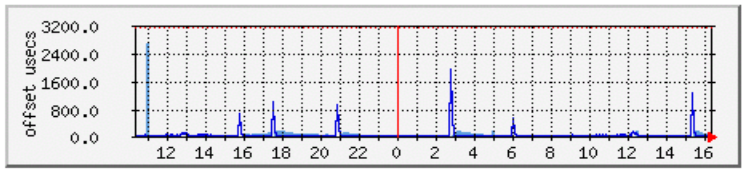


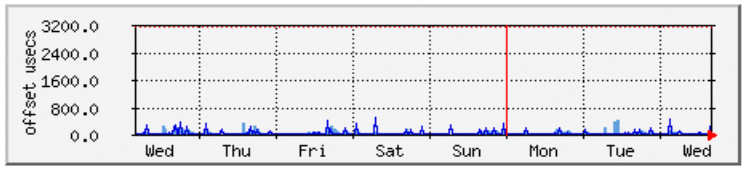


`Daily' Graph (5 Minute Average)



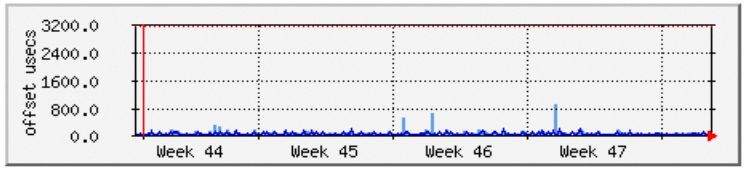
Max Positive Offset2697.0 usecs Average Positive Offset51.0 usecs Current Positive Offset75.0 usecs
Max Negative Offset1935.0 usecs Average Negative Offset34.0 usecs Current Negative Offset 0.0 usecs

`Weekly' Graph (30 Minute Average)



Max Positive Offset449.0 usecs Average Positive Offset53.0 usecs Current Positive Offset154.0 usecs
Max Negative Offset507.0 usecs Average Negative Offset27.0 usecs Current Negative Offset 0.0 usecs

`Monthly' Graph (2 Hour Average)



Max Positive Offset919.0 usecs Average Positive Offset66.0 usecs Current Positive Offset14.0 usecs
Max Negative Offset209.0 usecs Average Negative Offset33.0 usecs Current Negative Offset24.0 usecs

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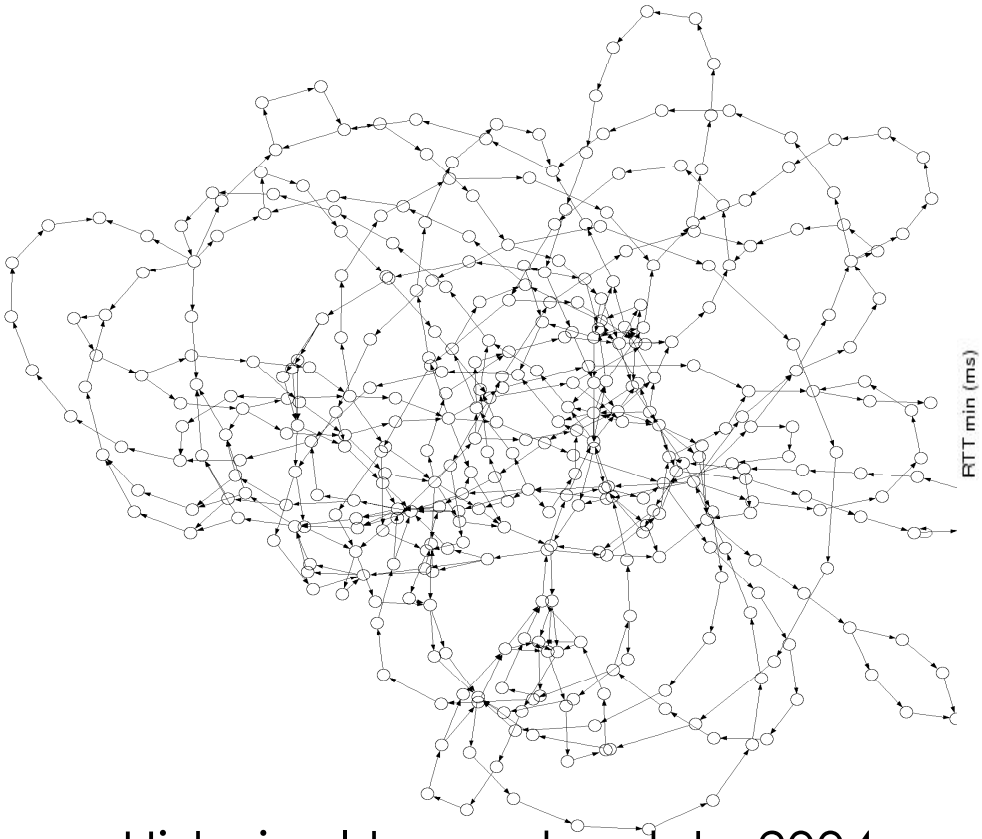
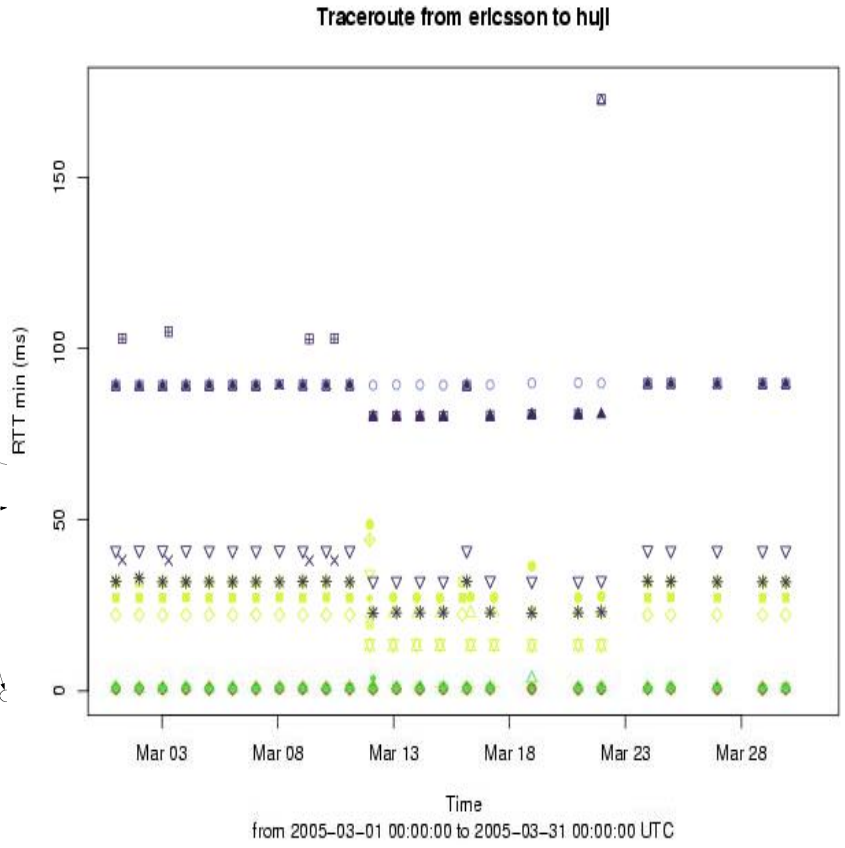
Tracking topology changes





- Historical traces back to 2004

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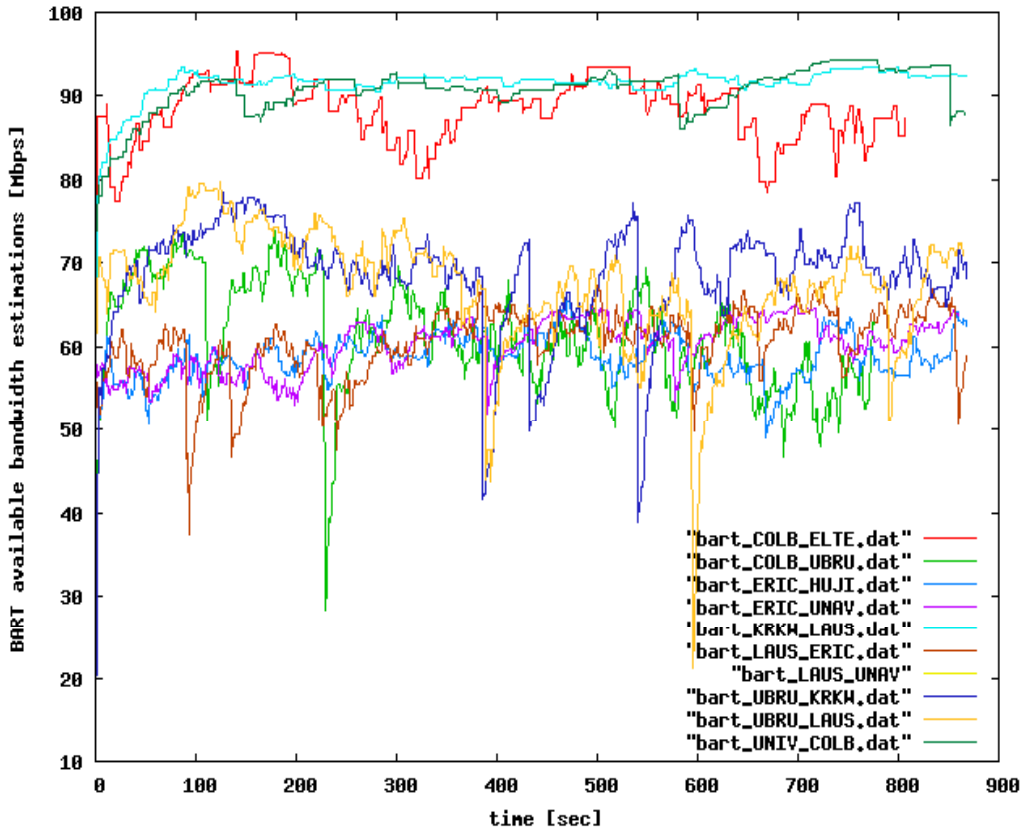
Testing new available bandwidth meters

- Upload your available bandwidth meter via the web interface. Deploy it to the sites of your choice. Book measurement time and schedule your experiment.



ERICSSON

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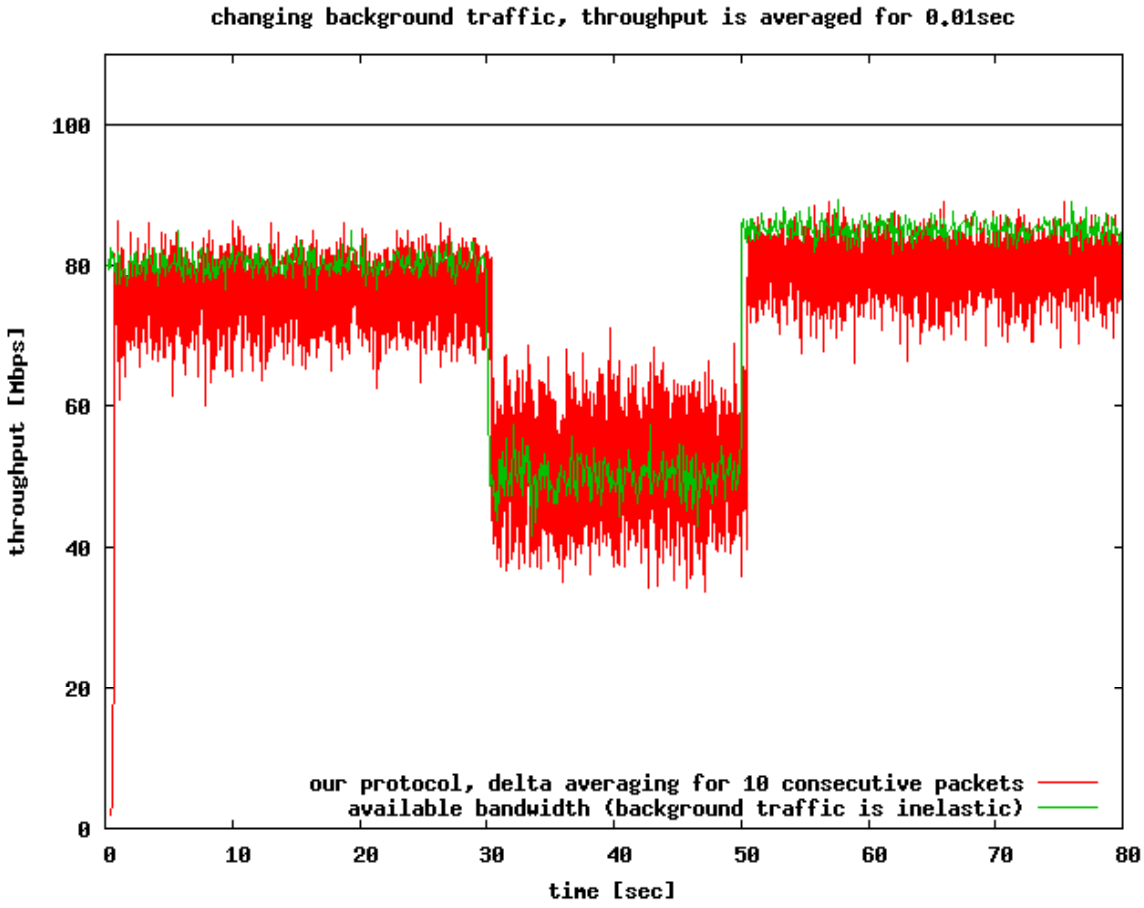
Transport protocol testing

- Upload a new protocol version as an experiment and test it in real Internet + custom designed cross traffic



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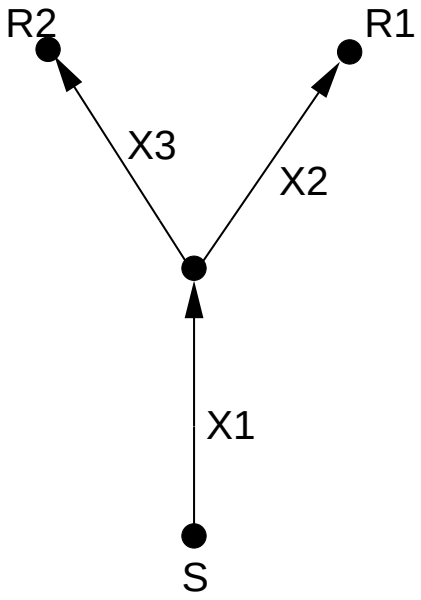
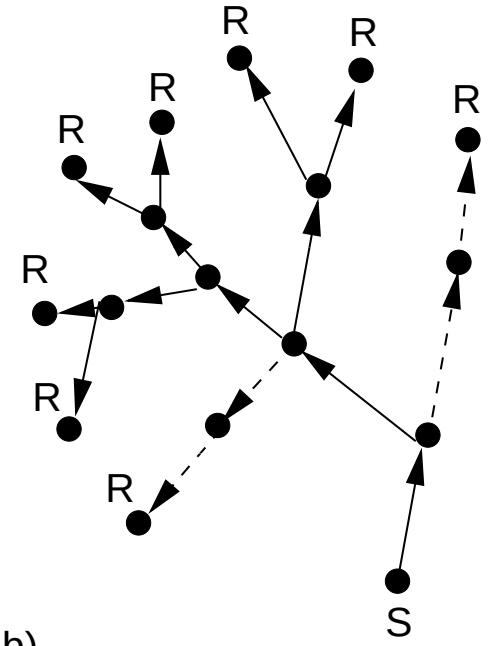
Queuing delay tomography

Goal: to resolve delay statistics on internal network segments too, where we do not have monitoring stations

Method: we send back-to-back packet pairs and measure their end-to-end delay at arrival with very high precision



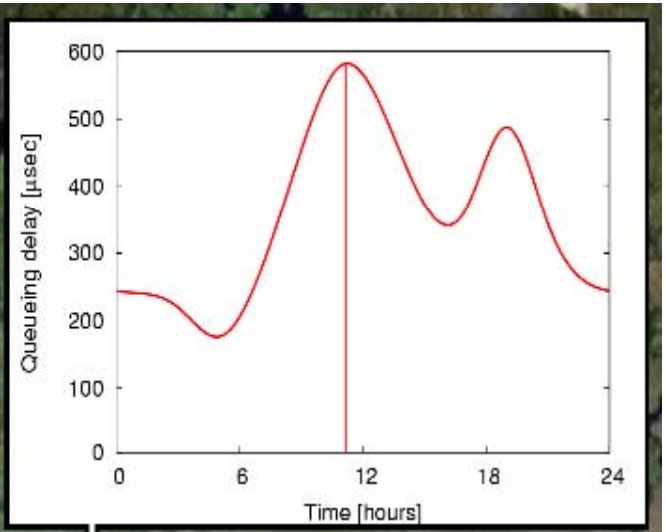
a)

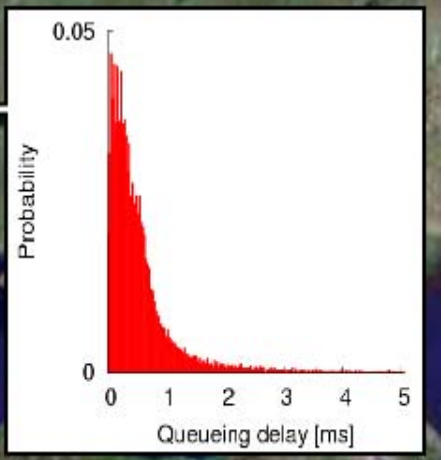


b)

Key idea: delay correlation on the common segment for the packets in a pair

Europe wide queuing delay tomography





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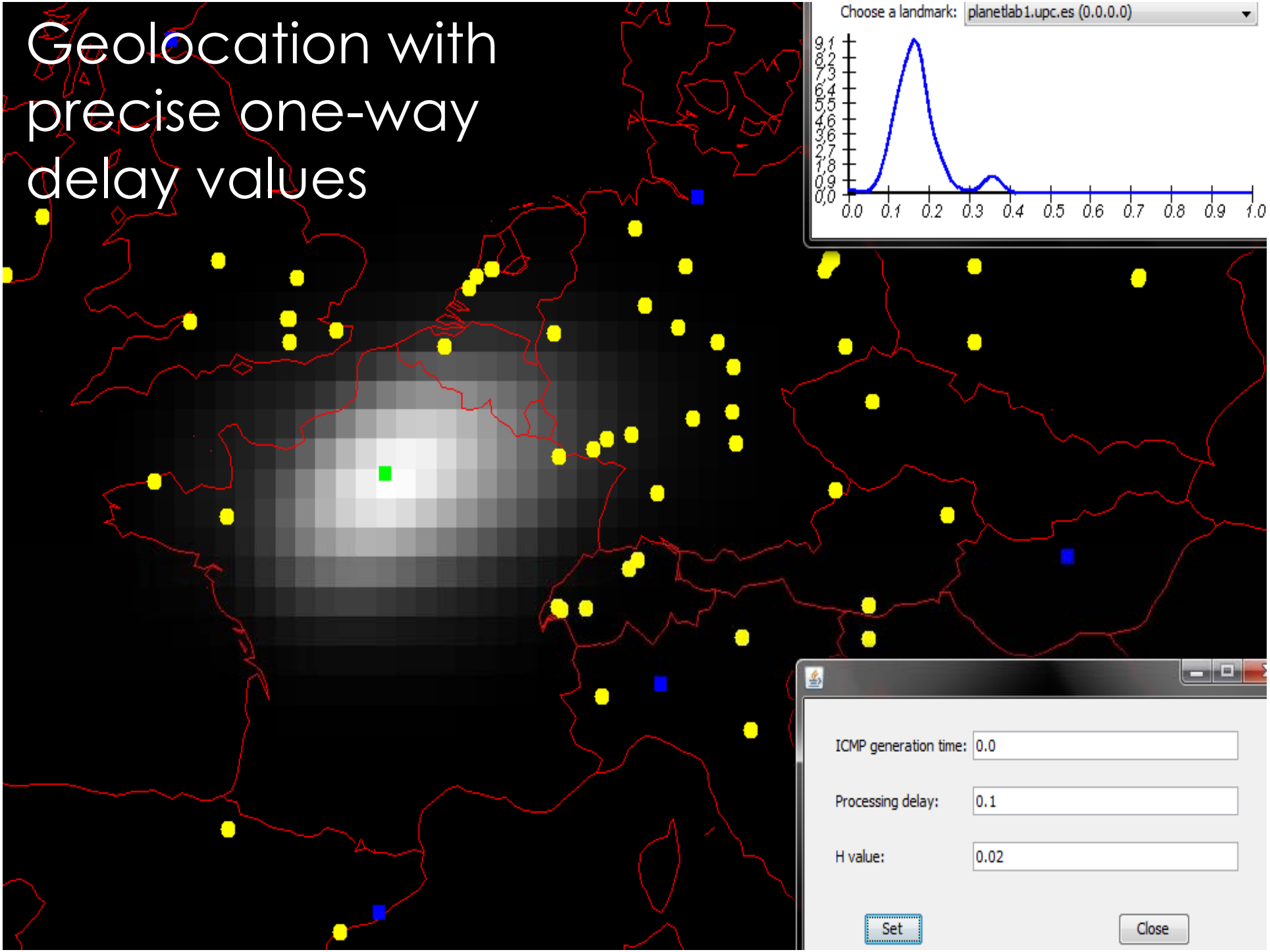
Geolocation with precise one-way delay values



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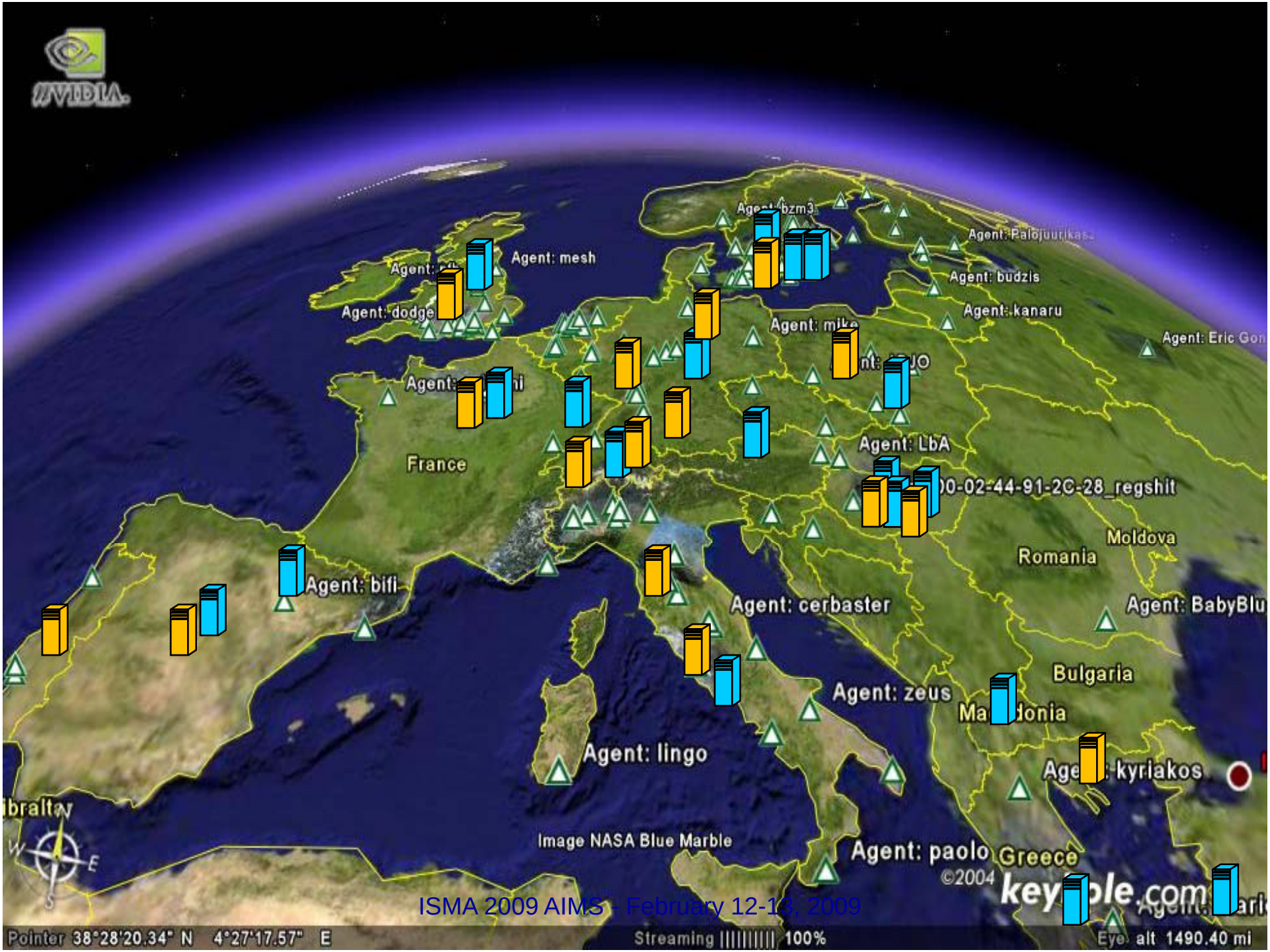
Summary

- „old" etomic is running
- „new" etomic will be launched this summer
- Main features:
  - Precise active measurements
  - Unique time slot reservation
  - Easy to use GUI
- European deployment (planned):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Moldova
Romania
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