WAMSTER AD-HOC SYNCHROPHASOR NETWORK: PRACTICAL EXPERIENCES GAINED IN 2011

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WAMSTER overview

- industrial grade device for synchrophasor research
- easy to configure and use, portable, no need for additional communication infrastructure
- data concentrator as a service, with a web-based interface

<table>
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<tr>
<th>STER PMU devices: lightweight, handheld PMUs with battery backup and SD card memory¹</th>
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<td>GRPS: optimized WAMSTER protocol</td>
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<td>Ethernet: optimized protocol or IEEE 37.118²</td>
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<td>WAMSTER web application: cloud data storage, accessible from anywhere, event-based triggering, analysis, interoperability</td>
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¹ 32GB card can store more than 4 months of synchrophasor data at the device side
² For mobile networks, custom STER protocol is recommended due to its additional features (adaptive reporting speed, historical requests, remote firmware upgrade, basic events). Note that device stores synchrophasors at 50/60 FPS locally.
WAMSTER components

TCP/IP Server
Ster Concentrator
Ster Logger
WAMSTER Server
Windows Services (.NET)

Web Interface
Real Time Data Provider
Historical Data Provider

Database
MS SQL Server 2008 R2

Web Server
ASP.NET
Case 1: CARWAMS

- Implemented for University of Rijeka
- Active from Sep 2010 until Sep 2011
- Hor.: 0.4kV, Vert.: 0.4kV - 110kV
- Data streaming towards TSO PDC
Case 1a: CARWAMS LV analysis

Transients:
- **50 fps** on demand

Long term baselining:
- Reporting at **1 fps**
- Daily fluctuations
- Seasonal changes

![Graphs showing angle difference and phase angle](image-url)
Case 1b: CARWAMS HV-MV-LV coverage

Shortcomings found:
- 1 fps insufficient for transients and oscillations
- 8 MB of flash memory was sufficient for only 77 minutes of data

HW upgrade:
- Removable SD flash memory card – 32 GB more than 4 months of data autonomy
- Ethernet connectivity for continuous 50/60 fps reporting rate

SW upgrade:
- Event detection/triggering
- Web access improvements
Case 2: Zagreb 110kV loop

- Installed in Sep 2011 (ongoing)
- Part of SIPS Project for TSO conducted by Faculty of Engineering Rijeka

Automated control system area

Power plant ELTO
- PPC

TSO
- PMU #11
- PMU #14
- PMU #10

TSO
- TSO
- PMU #3

TSO
- TSO
- PMU #8

Power plant TETO
- PPC

www.wamster.net
Case 2a: Zagreb 110kV Loop: closed loop transition

Continuous monitoring:

- Near real-time system dynamics monitoring
- Load modeling based on SCADA
- Evaluation of model dynamics
- Parameter tuning
- Reporting at 10 fps, with 50 fps for triggered requests

20-Oct-11 12:16:40
P = -45.9 MW
Q = -2.3 MVAr
Case 2b: Zagreb AVPS Loop: islanding caused by an operator mistake

\[ \Delta f = 1.2 \text{Hz} \]
Case 2c: Zagreb 110kV Loop: typical disturbances
**6 PMU devices** for the Zagreb AVPS Project including all the additional equipment (extension cables, tools,...)

**STER PMU** device connected to the terminals inside a cabinet.

**STER PMU** is small enough to fit into any place inside an electrical cabinet.

Web interface can be accessed on site, using any **web-enabled device**.

WAMSTER protocol supports **remote access** to the device using the web interface.

GPS device with magnetic support placed on a window or slipped under the door.
Try a live demo now

• Do you have a web-enabled device with you?
• Laptop / tablet / smartphone?
• [www.wamster.net](http://www.wamster.net) is available to you right now.

Contact

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Questions?

Thank you.