Hydrology

- Hydrological Sensors
- Data Logger
- Data Collection System
- Hydrological Database
- Water Quality Monitoring
- Hydrological Modeling
- Flood Forecasting & Warning

MicroStep-MIS
Solutions for the real world
MicroStep-MIS operates worldwide and it is specialised in development and manufacturing of monitoring and information systems, data acquisition and processing, research and numerical modeling.

The company’s key field activities cover:

• Meteorology and Climatology
• Aviation Systems
• Road Weather Information Systems
• Marine Systems
• Hydrology - Flood Warning Systems
• Microclimate Cave Monitoring Systems
• Seismology
• Radiation Monitoring Systems
• Air Quality, Emission Monitoring
• Crisis Information Systems
• System Integration as well as Turnkey Projects

Our global operations include the following customer groups: airports, port authorities, meteorological and seismological institutes, hydrological institutes, environmental authorities, industry and municipalities.

Activities of MicroStep-MIS cover the complete process of software and hardware systems development and integration. Our products and comprehensive services fully comply with the technical as well as quality standards (ISO 9001:2008, ICAO, WMO, EUROCAE), and they are supplied under very competitive financial and trade conditions.

Our highly qualified staff of developers and experienced researchers, dynamic product development process, and close cooperation with our customers guarantee the development and delivery of the most progressive and outstanding solutions.
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Hydrological Sensors

Water Level
Submersible pressure transmitter TSP-M is intended for a very accurate measurement of water level. For non-contact water level measurement at surface waters Radar Level Sensor is used. It is mounted above the water surface and uses impulse-radar technology to determine the water level.

Flow and Discharge
RQ-30 is intended for measurement of continuous discharge in rivers, open channels and canals with known cross-section profile. It uses innovative radar technology to measure velocity, water level and discharge and it enables reliable, non-contact measurement with no need of structural work in the water.

Mobile Systems
Among the mobile systems River Ray is suitable for use in both - low water as well as 40 m deep river or during floods to make accurate discharge measurements. StreamPro is intended for measurement of velocity and flow and it provides the results in just a few minutes.

Water Quality
Digital sensor C4E is used for measurement of conductivity or salinity and its use is the most common during urban wastewater treatment, industrial effluent treatment, surface water monitoring or drinking water analysis. Optical Dissolved Oxygen (OPTOD) sensor measures oxygen concentration and has the same application as the previous one. PHEHT - PH, REDOX & TEMPERATURE sensor has been designed to perform under hard conditions from pure mountains water with low conductivity as well as wastewater with conductivity higher than 200 mS/cm.

Ground Water Monitoring
Extremely stable and accurate digitally compensated pressure transmitters TSP and TSP LOG produced by MicroStep-MIS combine advanced piezorestive metal sensor and transmitter design. They measure differential pressure between atmospheric and atmospheric + hydrostatic pressure. They are designed for level measurement in tanks, wells, boreholes and watercourses.
The Data Logger AMS 111 II is designed for standard, temporary or mobile meteorological stations, as well as for the applications in areas where the commercial power or communication networks are limited or nonexistent.

The AMS 111 II interfaces with various sensors and telecommunication devices. Embedded with the state-of-the-art software, AMS 111 II is the reliable and cost-effective solution for meteorological and environmental monitoring.

Consisting of building blocks interconnected by RS 485 system bus, AMS 111 II serves as a modular and flexible platform for construction of various measuring and logging systems, which include AMS 111 II modules, intelligent sensors, displays and PCs.

System flexibility allows wide application range from simple compact system to multipurpose stations. 24 bit A/D conversion and software features such as data validation and quality control ensure the accuracy of the measured data.

System supports data output to RS 232/485 lines, modems and cellular phones (SMS, GPRS), radiomodems and satellites. PPP protocol support makes AMS 111 II Internet-ready.

User friendly software applications allow easy and comfortable system configuration, setup and maintenance also remotely via modem/PPP connection.

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**Hydrological Station Example**

- **Weather sensors**
- **Water level sensor**
- **Pressure sensor**
- **GSM Network**
- **Remote Data Collection PC**
- **Solar panel**
- **SD memory card**
- **LED indicator for operating**
- **Touchscreen graphic display**
- **Terminal board**

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Hydrological and meteorological data can be useful only after they reach the end-users. Information and communication technologies have never been more important in the world of hydrological monitoring.

IMS4 UDCS is a data collection and switching system built on the field proven IMS4 platform for meteorological, hydrological, radiation and environmental data acquisition and remote system maintenance.

**WMO Message Collection and Switching Capabilities**

The IMS4 UDCS supports wide choice of protocols defined by the WMO Manual on the GTS:

- SOH/ETX protocol for serial lines as defined by the WMO
- FTP file transfer (different formats)
- TCP/IP sockets as defined by the Attachment II/15 of the WMO Manual on the GTS
- E-mail
- AFTN gateway

The full-duplex mode of operation allows not only collection of the data from stations, but also distribution and switching of messages between/to the stations. The system fully supports creating and processing of the standard WMO codes SYNOP, METAR/SPECI, CLIMAT, GRIB, BUFR, CREX, etc. and it is open for the support of proprietary/national codes.

**OGC Formats, Image and Non-WMO Data Processing**

The UDCS supports numerous proprietary protocols and formats for communication with automatic weather, hydrological and environmental stations and data loggers, as well as for data distribution and exchange:

- OGC WaterML, NetCDF, OpenMI
- Text log-files (user configurable formats),
- National and/or international formats (EURDEP, ANSI N42.42),
- NWP model outputs,
- Dispersion model outputs,
- Radar, Satellite images,
- JPEG/PNG/other image formats, MPEG videos

**Station Network Management**

The station management module allows the operator to manage the station metadata, to define the data download plans as well as to poll the current or historical data manually or to connect to the remote station and perform the station inspection/maintenance/reconfiguration.

**Supported Interfaces:**

- Web services
- LAN/WAN/VPN, Ethernet, GPRS/GSM
- File based data transfer (file, FTP, sFTP, scp)
- MODBUS
- Proprietary (MicroStep-MIS, PAKBUS)
- Asynchronous leased lines
- and dial-up lines with dial-in, dial-out options (both periodical and manual)
Scalability, Fault Tolerance and High Availability

The IMS4 UDCS runs on standard PC, or fault tolerant server with redundant components or even a high availability cluster of two servers running in a hot failover mode, providing more and more safety for your data.

Public map view

Network management status screen

Metadata management (stations, instruments)
Hydrological Database

Hydrological (forecasting and warning) service requires operative data from meteorological and hydrological sources and various archive data. Storing of data in one database is a real advantage in operative usage of this data.

HydroDatabase consists of meteorological and hydrological part and it is filled by data of different sources, format and time step. Harmonization and sorting of data is necessary. Wide spectre of incoming data requires QC (Quality Control) for ensuring of appropriate data format.

Data types stored in HydroDatabase:

Operative

- meteorological
  - station measurement – precipitation, temperature
  - distant measurement – radar data
  - combination of station and distant measurement
- hydrological - water stage, precipitation, temperature, water temperature

Static data

- stage-discharge relation curve
- cross-section profile
- station data
- service diary
- discharge measurement diary

Advantage of Hydrodatabase is its modular architecture, which gives the end user the possibility of detailed customization. The end user can specify additional non-standard input and output modules. Modules can be easily implemented and added to any existing or future installation.

Server and the standard data access is based on SQL language. The guarantee of data storage quality is the industry-proven Oracle® Database Server, the world leader in database technologies.

Main advantages of the system (in addition to the above mentioned modular architecture) are:

- Quick accessibility and availability of data from meteoestations and raingauge stations (precipitation and temperature) and watergauge station data (water level/discharge).
- Harmonisation of data types in database
- Selection tools for type, location and time frame of chosen data
- Ability of manual inserting of data (in case of missing data)
- Export tools (to CSV, TXT, XLS or other relevant formats)
- Outputs in the form of maps, tabs and graphs

Modular System of System
Outputs of database are easy available in various formats:

- tables (directly in the database interface, or in the export format)
- graphs
- maps

Database is connected to map server, data are refreshed due to selected location, source, station, parameter and time frame. Database includes modul for manual entry of data in the case of false data or data gap occurrence.

Database is connected with other modules and data are directly used for hydrological modeling in a real time.
Water is the source of life. It is one of our most necessary sustainable resources. While it may appear that the Earth has abundant water resources, as water covers approximately 70% of its surface, it is important to realize that only 1% of the total available supply is a readily useable resource to support drinking, sanitation, agriculture, industry and other needs.

Effective water quality monitoring is the key to environmental protection of watercourses and for reliable process control and wastewater treatment.

**IMS4 Water Quality Monitoring System**

MicroStep-MIS IMS4 Hydrological and Water Quality Systems provides the turnkey solution for the measurement, data acquisition and processing, as well as reporting meteorological, hydrological and water quality parameters.

IMS4 Water Quality provides monitoring of:
- Surface water
- Underground water
- Drinking water
- Waste water
- Water in technological processes

Water quality parameters are continuously monitored on site and recorded by a data logger; results can be either manually downloaded or automatically sent to a website in real-time.

Monitoring of parameters directly in water with no need of any sampling system:
- Water level
- Temperature
- pH
- Dissolved Oxygen
- Conductivity
- Turbidity
- Color
- Oil in water

**Sample Capture**

**Automatic Analysis**

**Control Center**

**Exploitation and Analysis of Information**

Transimission of real-time data
**Monitoring Station Block Diagram**

Typical automatic analytic systems require water take-off, filtration, suitable analyzers, data acquisition and communication system.

### Features

- Select: data Selection
- Reports
- Manual data entry
- Monitoring of network hydroposts
- Long-term QC
- CSV import

**Main Menu**

**Display of Actual Data**
Hydrological Modeling

The complex network of models is used for the water level and discharge Rainfall - Runoff forecast or 1-D/2-D hydrodynamic calculations. The variety of models is ranging from simple empirical formulas based on standard equations (Muskingam) to complex rainfall - runoff or hydraulic models with deterministic or ensemble data sets.

The advanced system for models configuration and management is a part of the IMS4 Model Suite. The model system is fully connected to HydroDatabase for input and output data.

The data visualization and processing is also fully integrated into the hydrological portal. System uses wide range of input data:
- Measured station data - temperature, precipitation, water level, discharge
- Measured data from distance measurement
- Deterministic model forecasts
- Ensemble model forecasts

Following hydrological models have been integrated:
- Models for rainfall-runoff modeling and forecasting (HBV, HYPE, HEC-HMS)
- Models for 1-D/2-D hydraulic modeling and flood hazard mapping (HEC-RAS)

The advantage of model system is its complexity, which enables the user (forecaster) to solve wide range of problems in hydrology:
- Forecast of discharge / water level for certain place and time
- Forecast of inflow to dams
- Modeling of the hydraulic structures such as bridges, culverts, dams, weirs and spillways. The manipulation with these structures.
- Backwater effects
- Flood hazard mapping

Standard advantage of HEC-RAS models is connection to GIS, which enables to increase the amount of outputs of HD modeling from simple water level forecast to the extent of possible flooding. Construction of maps of flood hazard is also possible.

![Hydrograph of outflow computed by several models for such river profile](image-url)
The most required output of hydrological models is the set of values of discharges in certain time for certain place (river profile) – hydrological forecast. This forecast could be base information for hydrological warning issue – in automatic, semi-automatic, or manual way.

Deterministic and Ensemble Forecasting

Deterministic hydrologic forecast is based on deterministic run of meteorological model. This forecast is user friendly and is free of doubt.

In order to cope with the uncertainty in forecast models (imperfect initial conditions amplified by the chaotic nature of the evolution equations of the dynamical system, errors introduced due to imperfections in the model formulation, etc.), the IMS4 Model Suite has the built-in support for the ensemble forecasting, including the possibility of the calculation of the ensemble statistics (forecast mean, median/percentiles, etc.).
Hydrological Modeling

Output of ensemble rainfall - runoff model

IMS4 Maps
Publication of the spatial data is based on open standards. easy-to-use standard web map interface integrating the best of the information technologies and environmental sciences is used.

IMS4 Maps is based on the map layers concept with various functionalities allowing zoom, rotation, layer reordering and many more.

It has been designed and developed to share your meteorological data with the end customers in aviation and transport industry, civil protection or with general public.

The IMS4 Maps processes the data in numerous formats and allows the export of georeferenced meteorological data in various formats enabling their display in the forms of the colored fields, isolines, wind barbs, etc.

Integration with IMS4 WeatherStudio
All the IMS4 ModelSuite products can be visualized using IMS4 WeatherStudio application.

Conformance to Standards
IMS Model Suite is in compliance with the numerous international/industrial standards such as WMO, ICAO, OGC, etc.

- Open Geospatial Consortium:
  - KML
  - NetCDF
  - OpenMi
  - WaterML
  - Web Map Service
  - Web Feature Service
- World Meteorological Organization:
  - WMO No. 306 Manual on Codes

IMS4 Maps (from the left): wind and relative humidity, wind and temperature, wind and precipitation
Flood Forecasting & Warning

Flash Floods
When integrated with the precipitation nowcasting system, IMS4 Model Suite Flash Flood module provides the early warnings for the rapidly developing, spatially limited flash floods. The system based on the concepts of Flash Flood Guidance and Flash Flood Threat uses the GIS data (terrain slope, land use, soil characteristics) and rainfall data (gauge/radar) and performs the real-time comparison of observed or forecast rainfall volume of a given duration at the grid points to a characteristic volume of rainfall for that grid that generates flooding at the particular locations.

Flood Warning System
Flood mitigation requires knowledge of the meteorological and hydrological conditions in the past, at the present and forecast into the future.

The complete flood warning system can be provided on a turnkey basis:
- Automatic weather and hydrological stations
- Remote sensing systems
- UDCS/EnviDB – the data acquisition and operational/long term database
- IMS4 Model Suite – NWP and hydrological models
- Map Server and/or IMS4 WeatherStudio – hydrological situation visualization

The system is able to compare the outputs of hydrological models with national warning levels and inform forecast officer in the case of exceeding of such level. Automatic Warning Issue and Dissimation is possible, but not recommended. System is able to process outputs of hydrological models, as well as outputs of Flash Flood Forecasting System.

Assessment of flash flood potential in Slovakia
1x1 km grid

Warning issue for flash flooding