

Application-Consultancy

Advanced MERMAID-Technology

Automated Pollution Monitoring of
coastal zones / rivers / waste water

- Our offer:
- complete systems
 - components
 - engineering
 - consultancy
 - training



Advanced MERMAID Data System

Concept

The "Advanced MERMAID-Data System" is an automated, remote-controlled monitoring system for different applications in the aquatic environment. The centrepiece is a modular and versatile data system on the measuring station and at the office (land-based station), connected by a bi-directional telemetry.

The applications of the "Advanced MERMAID-Data System" range from automated monitoring of coastal areas, river/lake applications to industrial and domestic waste water control.

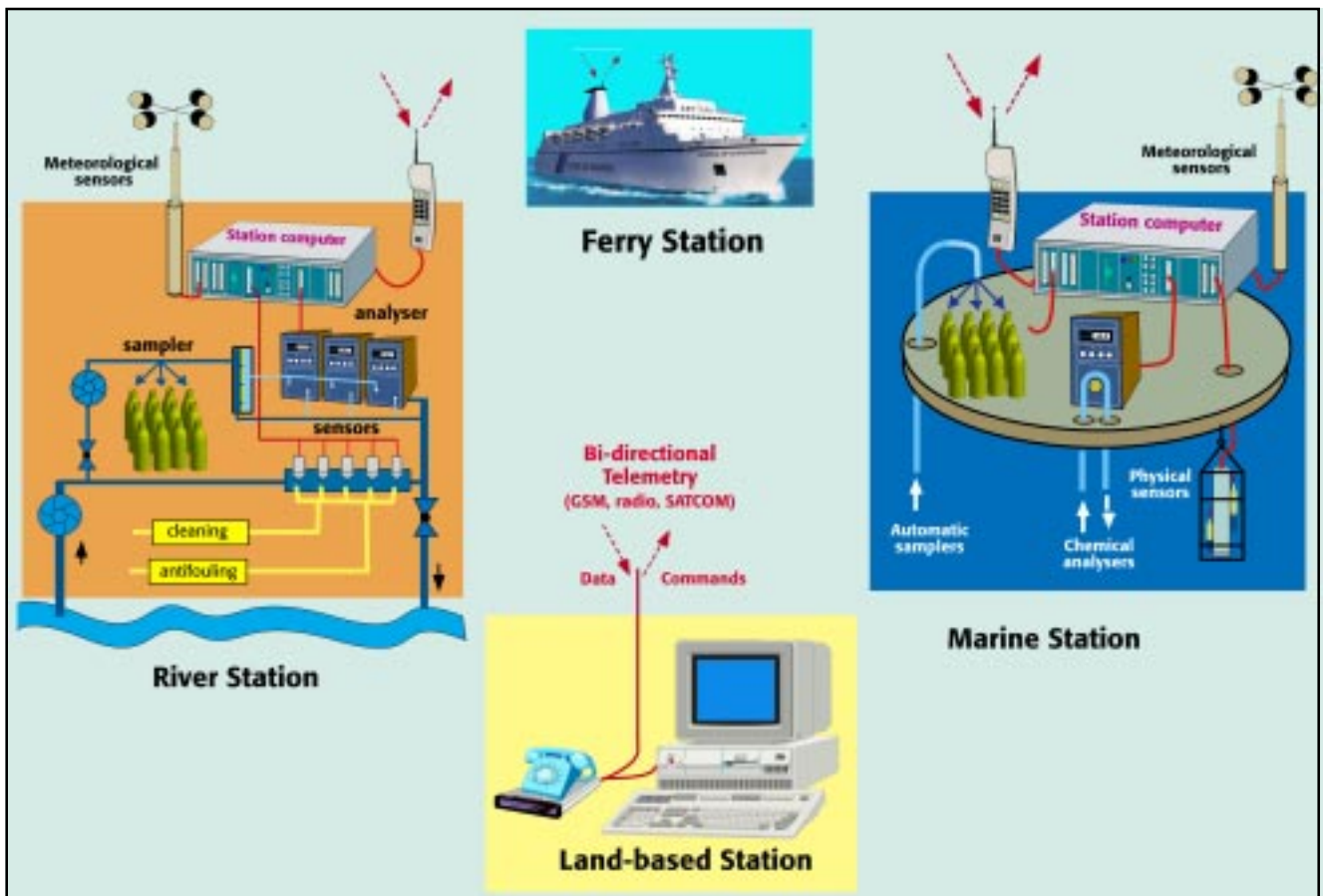
The "Advanced MERMAID-Data System" is especially predetermined for automated handling and remote control of complex biological/chemical sensors and analysers.

In contrast to many data systems on the market the "Advanced MERMAID-Data System" can be easily adapted to new sensors and chemical analysers provided by the customer or other manufacturers.

In complex environmental networks **one** "Advanced MERMAID-Data System" can be used for coastal and riverine control

The "Advanced MERMAID-Data System" originates from the "Original MERMAID-Technology", improved and supplemented with hard- and software modules which were derived from years of operation by different users, e.g. German monitoring authorities.

Operational Principle



Available Systems

Coastal System

- System on buoys, piles, platforms or light ships
- In situ sensors for meteorology, oceanography and biology
- All sensors from reliable manufacturers
- Online analysers for nutrients
- Event-controlled sampling
- Energy-optimized
- Telemetry: GSM, radio, Satcom

River System

- System in a container at the banks of the river
- Continuous pumping
- Electricity needed
- Online sensors for standard water quality parameters
- Online analysers for nutrients, total organic carbon (TOC)
- Event-controlled sampling
- Telemetry: Phone, GSM, radio

Ferry System ¹⁾

- System on ferries or ships-of-opportunity
- Continuous pumping
- All modules in metal racks, according to safety regulations
- Online sensors for oceanographic, biological and chemical parameters
- GPS position
- Telemetry: GSM, radio, Satcom

Waste Water System ²⁾

- Modular systems for control of emissions from waste water effluents
- Basic "Standard System" comparable to "River System"
- Additional chemical analysers for specific effluents, e.g. metals or organics
- Development of special analysing procedures

1) under testing

2) under development, "tailored" for customers need



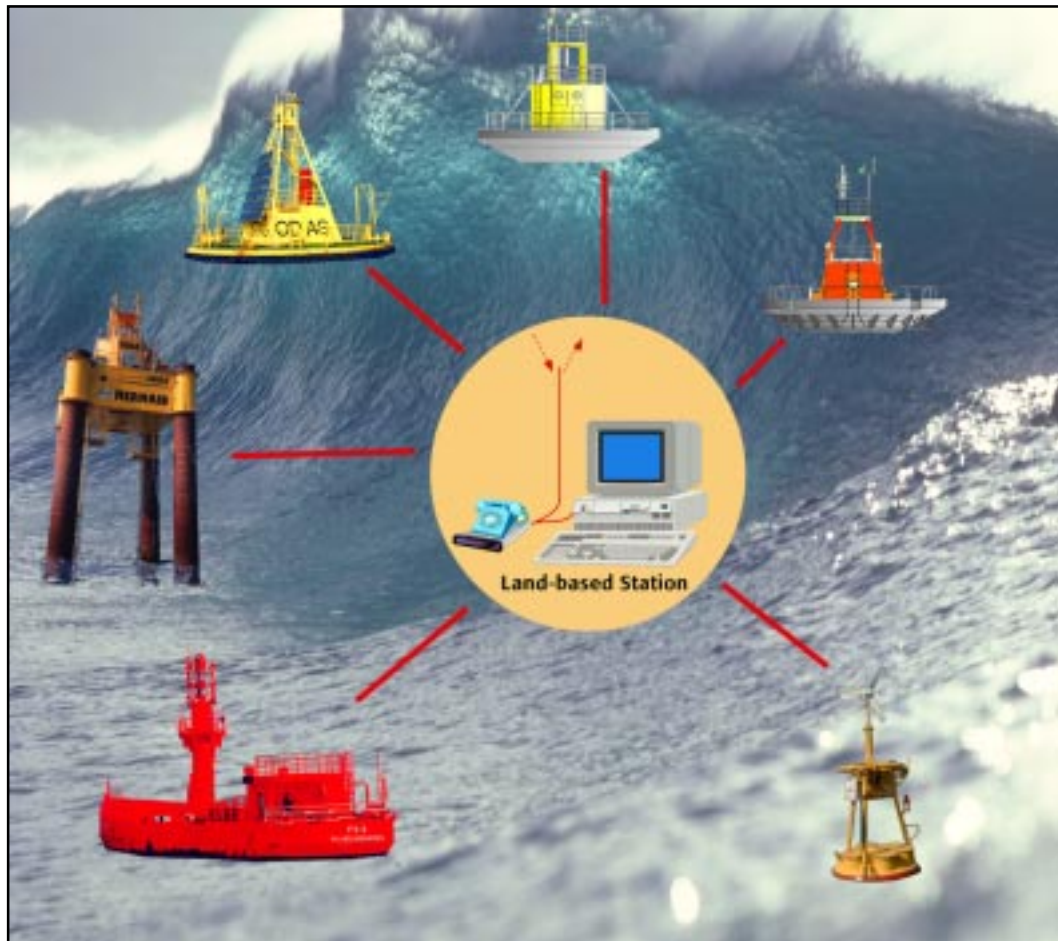
Coastal System

Characteristics

The "Advanced MERMAID Coastal System" has been developed for automated, cost-effective monitoring of coastal areas and estuaries. This system is always the best choice if energy constraints are important (solar cells + wind energy) and a remote station (buoy, pile etc.) has to be equipped with in situ instruments.

The modules of the data system are mainly the same as in all other *Advanced MERMAID Systems*. However, a special energy management takes care of the restricted energy supply and special precision sensors are selected which fulfill the requirements of oceanography (e.g. accuracy of salinity/temperature measurements). Other sensors or analysers are selected for the prevailing small concentration ranges in coastal areas (e.g. chlorophyll, turbidity and nutrients).

- System with all infrastructure can be installed on a customer-chosen platform (buoy, pile, light ship etc.)
- Use of in situ sensors -where possible
- Pumped water supply (switched on once per hour) only for chemical online analysers
- Precision sensors and nutrient analysers from reliable manufacturers are integrated
- Event-controlled sampling
- Cleaning of sensors: Depending on environmental conditions once per month (once per fortnight in tropical regions¹⁾)



Typical Sensor Configuration

Meteorology

- wind speed and -direction
- global radiation, PAR
- air humidity
- air temperature
- air pressure

Oceanography

- water temperature
- water level
- current speed/-direction
- conductivity
- turbidity
- oxygen

Chemical/biological

Sensors

- chlorophyll
- pH
- algal classes¹⁾

Analysers

- NH_4 , NO_3/NO_2 , PO_4 , SiO_4

Sampler

¹⁾ under testing

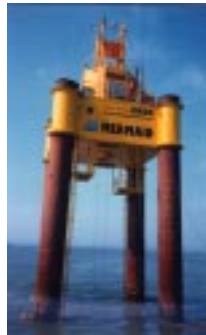


Coastal System

Typical Examples of Carrier Systems



GKSS buoy "META" (13m \varnothing)



Former GKSS platform



Sensor frame on platform



Equipment on GKSS platform



Measuring pile in Weser estuary)



4H buoy (2.5m \varnothing)



Maintenance on 4H buoy

Carrier systems for the "Advanced MERMAID Data System" can be chosen by the customer. The type and size depends on the topographical and oceanographic conditions of the sea area (windspeed, wave height, sediment conditions etc.).

Typical Examples of Sensors and Analysers Manufactured by 4H Jena Engineering

Conductivity



Specifications

Principle: Inductive
Range: 0-50 mS/cm
Accuracy: 1 % F.S.
Output: 4-20 mA

water level



Specifications

Principle: Wire strain
Range: on request
Accuracy: 1 % F.S.
Output: 4-20 mA

pH



Specifications

Principle: Electrode
Range: 4-10 pH
Accuracy: ± 0.1 pH
Output: 4-20 mA

Oxygen



Specifications

Principle: Clark cell
Range: 0-20 mg/l
Accuracy: ± 0.2 mg/l
Output: 4-20 mA

Current



Specifications

Principle: Magnetic-inductive
Range: -5 -- +5 m/s
Accuracy: 1 % F.S.
Output: 4-20 mA

From other manufacturers

Current



Specifications

Manufacturer: ME Grisard
Type: SM 42
Principle: acoustic phase shift
Range: 0-2, 0-6 m/s
Accuracy: 1 % F.S.
Output: 0-20 mA, digital

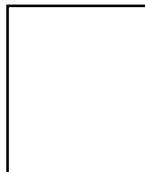
Chlorophyll



Specifications

Manufacturer: ME Grisard
Type: IL 2120
Principle: Fluorescence
Range: 0.03-250 mg/m³
Resolution: 0.03 mg/m³
Output: 0-20 mA, digital

Chlorophyll



Specifications

Manufacturer: Chelsea
Type: Aquatracker III
Principle: Fluorescence
Range: 0.01-100 mg/m³
Accuracy: ± 0.02 or 3% FS
Output: 0-4 V

ADCP



Specifications

Manufacturer: Aanderra
Type: RCM 11
Principle: ADCP
Range: 0-300 cm/s
Resolution: 0.3
Accuracy: ± 0.15 cm/s
Output: Aanderra SR10

Nutrients



Specifications

Manufacturer: ME Grisard
Type: APP 5003
Principle: Batch analyser photometric
Parameters: NH₄, NO₂/NO₃, PO₄, SiO₄
Special: programmable
Signal out: RS232 (0-10 V)



River System

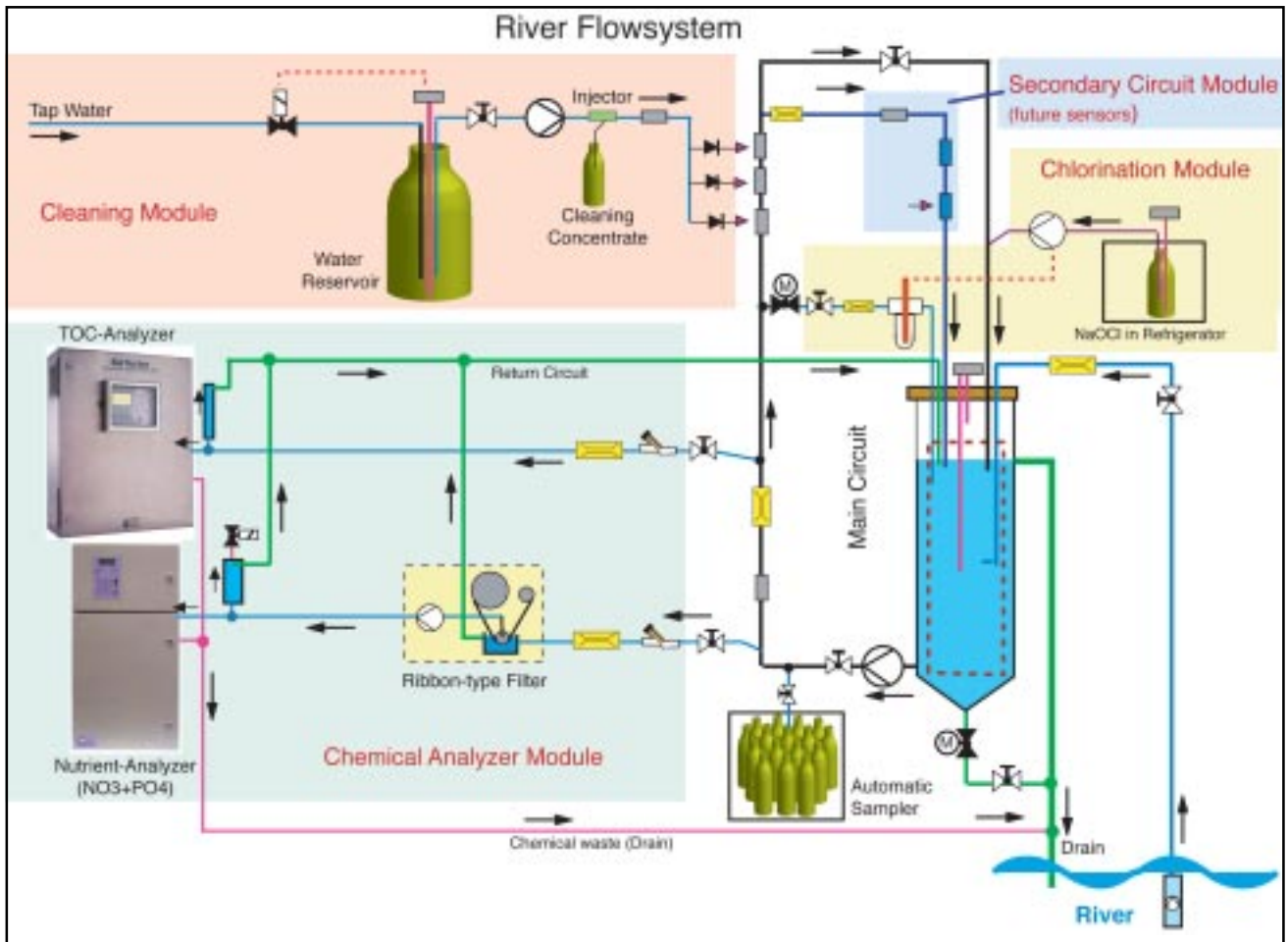
Characteristics

The "Advanced MERMAID River System" has been developed for automated, cost-effective river monitoring. This system is always the best choice if enough energy is available and water can be pumped into a container at the bank of the river.

The modules of the data system are mainly the same as in all other *Advanced MERMAID Systems*. However, special hydraulic and analytical modules take into account the special requirements for water quality control of rivers, lakes or drinking water reservoirs.

- System with all infrastructure installed in a weatherproof, air conditioned 10-foot container
- Water is pumped by an underwater pump through a specialised flow system (see below)
- The flow system has reliable and tested online sensors for standard water quality parameters from reliable manufacturers
- Chemical analysers from reliable manufacturers are integrated
- Event-controlled sampling
- Depending on environmental conditions optional cleaning and antifouling modules can be integrated
- Maintenance interval: Once per month (once per fortnight under tropical conditions¹⁾)

Operational Principle of the Flow System



Typical Sensor Configuration

- | | | | |
|---|--|--|--|
| <p>Meteorology</p> <ul style="list-style-type: none"> • wind speed and -direction • global radiation, PAR • air humidity • air temperature • air pressure | <p>In situ (outdoor)</p> <ul style="list-style-type: none"> • water temperature • water level • current speed • current direction | <p>Water Quality (Sensors)</p> <ul style="list-style-type: none"> • conductivity • turbidity • oxygen • chlorophyll • pH • algal classes¹⁾ | <p>Water Quality (Analysers)</p> <ul style="list-style-type: none"> • ammonia • nitrate/nitrite • o-phosphate • silicate • organic carbon (TOC)¹⁾ |
|---|--|--|--|

1) under testing

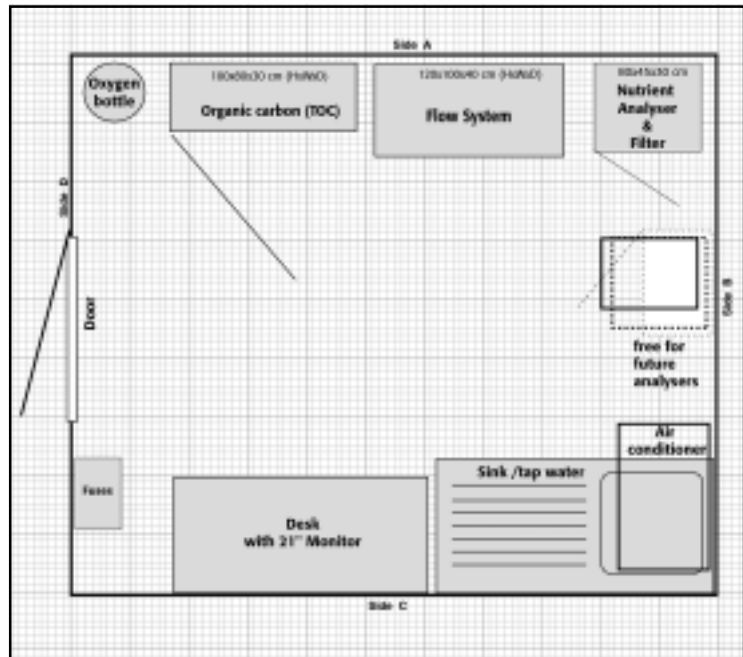


River System

Components of the River System



Foto of the flow system



Arrangement of equipment in the container

Typical Examples of Sensors and Analysers

Oxygen Sensor (Endress & Hauser)



Specifications

Type: COS3
Principle: Clark cell
Range: 0-20 mg/l
Resolution: 0.01 mg/l
Accuracy: ± 0.75% F.S.
Temp.compens.: autom.
Pressure comp.: manual
Salinity comp.: manual
Signal out: 0(4)-20 mA

Turbidity Sensor (Endress & Hauser)



Specifications

Type: CUS31
Principle: 90° scatter
Range: 0-9999NTU
Resolution: 1 NTU
Cleaning: Wiper(auto)
Signal out: 0(4)-20 mA



Conductivity Sensor (MeCoTec, Germany)



Specifications

Type: MECON-4R
Principle: 4-conductor
Range: 0-0.4;4;40 mS
Accuracy: ± 1% F.S.
Signal out: 0(4)-20 mA

Nutrient Analyser (SYSTEA, Italy)



Specifications

Type: Micromac MP
Principle: Loop-flow analysis photometric
Channels: 2 or 4
Analysis: Sequential
Analys. time: 8-10 min
Parameters: NH₄, NO₂/NO₃, PO₄
Range: depends on param.
Options: integr. Peltier element for cooling of reagents
Signal out: 4-20 mA, RS232

Nutrient Analyser (ME Grisard, Germany)



Specifications

Type: APP5003/ 6003
Principle: Batch analyser photometric
Channels: 1
Analys. time: 8-20 min
Parameters: NH₄, NO₂/NO₃, PO₄, SiO₄
Special: programmable
Signal out: RS232 (0-10 V)



Other Parameters

(higher conc./waste water)
Fe(II/III), Mn(II), Cd, Ni(II), Ca, SO₄²⁻, F⁻, CN⁻
Formaldehyde, hydrazine, acetone, phenol index

Organic Carbon/COD (BioTector, Ireland)



Specifications

Type: BioTector970
Principle: O₃-oxidation
Range: 0-10,3000 mg/l
Accuracy: ± 5 % F.S.
Samp. volume: 0.1 - 8 ml
Particle size.: 2 mm max
Cleaning: autom.
Signal out: 0(4)-20 mA



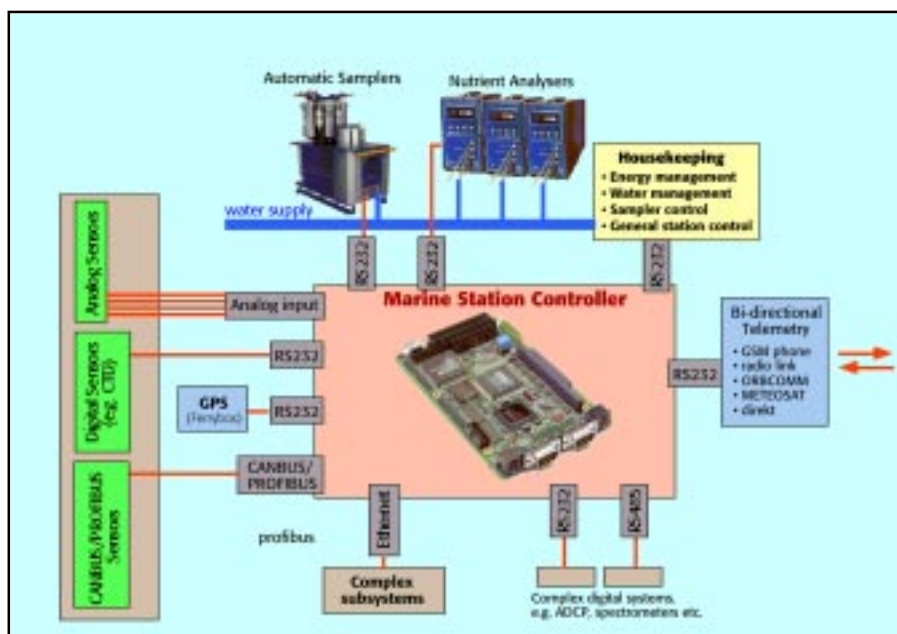
Data System for all Applications

Characteristics

The data system which is nearly identical for all applications is a modular, versatile tailor-made data handling system which covers all important monitoring tasks as data acquisition, -telemetry, -storage and -presentation. In contrast to many simple data loggers it features full control of all equipment on the remote (marine or river) station from the office by bi-directional telemetry. On the other hand, all sensors and the more sophisticated online analysers on the remote station are controlled and "supervised" by the system. Failures are detected (remote diagnosis) and often can be corrected from the office (e.g. by downloading of software modules). New sensors can easily be integrated either by the customer (a "cooking recipe" with documentation is part of the software package) or by 4H Jena Engineering.

- error-tolerant system
- simple handling
- online documentation, online help
- messages in plain English or German
- database with import/export
- remote diagnosis via telemetry
- quality control of data & procedures
- open architecture
- documented interfaces
- tailorable for performance and costs
- data presentation via internet
- secure system

Marine/River Station



Typical Configuration of a large marine/river Station

The hardware of the marine/river station consists of PC-compatible, industrial components. Depending on the application (number of interfaces, space, energy, type of carrier system etc.) different components can be chosen (single board computer or 19" systems).

Hardware



PC in 19" frame for large systems with many interfaces



PC 104 single-board for small, energy-minimized systems

Software

- works on all standard PC hardware
- acquisition of data from analog and digital sources
- quality check of raw data
- computing of physical values with
 - basic mathematical functions
 - polynomial functions
 - trigonometric/hyperbolic functions
 - UNESCO formulas for seawater
 - special calibration functions, e.g. for PT100, O₂
 - integrals for smoothing
- averaging of physical data (10 s to 1 h)



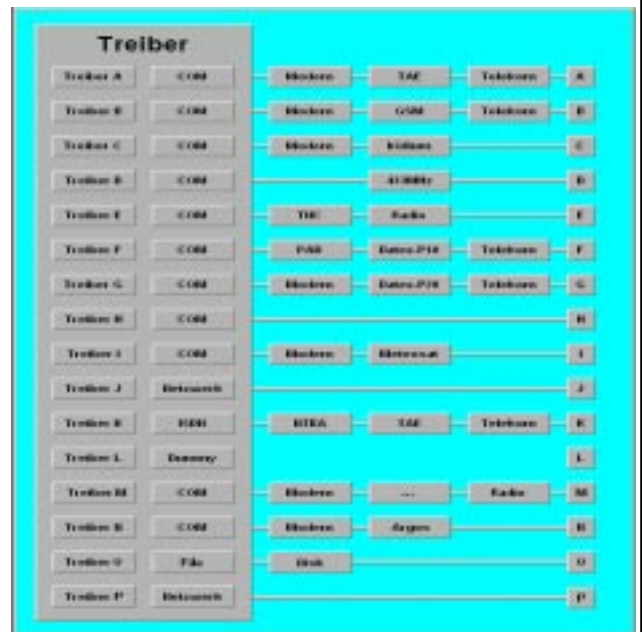
Data System for all Applications

Telemetry

The task of the telemetry is a cost-effective bi-directional communication between office (land-based station) and the marine/river station. The customer can choose between different telemetry modules, according to his needs, e.g. cellular phone (GSM) for near shore locations or satellite communication for distant coastal regions. It is possible to use two or more telemetry modules at the same time, e.g. one for commands and another for the "bulk" data.

Examples for telemetry modules

- Cellular phone (GSM)
- Telephone line (modem)
- radio (VHF) with packet radio(digital) modem
- radio modem (433 MHz)
- ARGOS satellite (uni-directional, ~ 10-30 kB/day)
- METEOSAT satellite (uni-directional)
- ORBCOM satellite (mailbox principle)
- local: RS232, TCP/IP



Menu on land station for choice of telemetry

Land-based Station

The hardware of the land-based station consists of a standard *Pentium IV/1.5 GHz* processor with 21" monitor. The operating system is *Windows NT* or *Windows 2000* with standard resources.

Characteristics

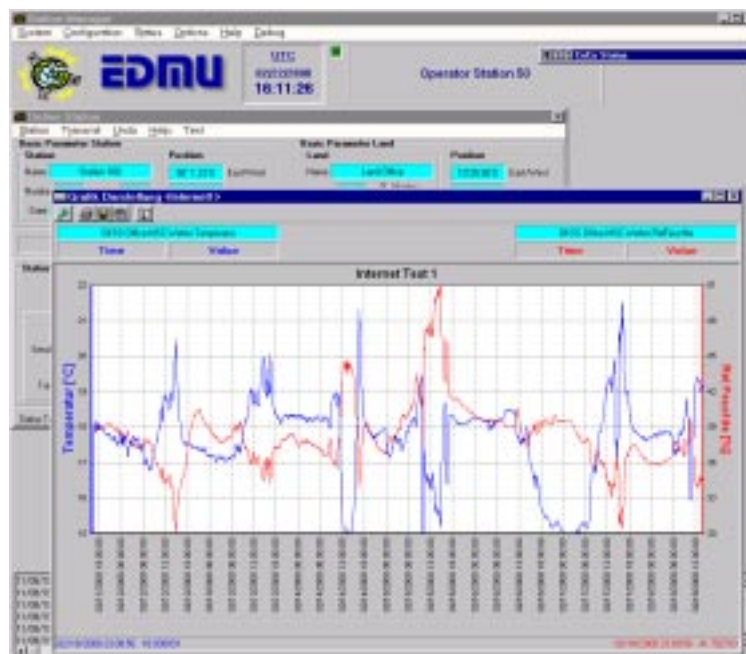
- networking functions (remote diagnosis, multi-user, data presentation, data import/export via internet)
- optimised data base for administration of large data sets
- simple user interface with online help functions
- implementation of new devices by the user in a programming language of his choice, e.g. C++, DELPHI, Visual Basic
- "tailor-made" program modules according to user needs
- multi-language user interface
- tools for diagnosis, administration and error detection
- tools for remote diagnosis on the marine/river stations

Database

As standard data base "PARADOX" is used, since the access time is about 10 times faster than with SQL-oriented data bases. However, for special user needs the implementation of *dBase* or *ORACLE* is possible due to the *Borland Database Engine* as interface.

Different database tools are included in the software which allows the maintenance of large databases (e.g. back-up, restore, and repair).

Data import/export from and to MS EXCEL/ ASCII is carried out directly from the user interface of the land-based station.



Example for data display on the land station

Consultancy and Training

System Design

- Design of automated systems for water quality monitoring according to the specific needs of the customer
- Design of "tailor-made" systems for measurements of oxygen, chlorophyll, algal species, nutrients (ammonia, nitrite/nitrate, o-phosphate, silicate), pH, turbidity, temperature, conductivity, current velocity, -direction, water level, meteorological parameters.
- Adaption and integration of process equipment from different manufacturers into automatic monitoring systems, e.g., algae monitors, BOD/COD, oil analysers etc.

Training & Education

- Training of personnel for monitoring tasks; this includes instrument handling, instrument maintenance, quality control and on request may include "traing on the job".
- Education of scientists for monitoring strategies, data evaluation and water quality management

Project Implementation and Consultancy

- Project design for specific monitoring tasks; this may include measurements, data evaluation strategies, modelling and statistical approaches
- Project planning, project coordination and project implementation for integrated monitoring projects (automated monitoring networks + data evaluation + modelling).
- Consultancy for specific problems in water quality control, water quality assessment and water quality management etc.

References

- MERMAID stations in the Elbe estuary, operated by the GKSS Research Centre for development purposes
- MERMAID technology installed in the official German monitoring network "MARNET", operated by the German monitoring authority "Federal 'Maritime and Hydrographical Agency, BSH" in the North Sea / Baltic Sea
- "Advanced MERMAID Technology" as prototype system for Asian waters in Indonesia ("Brantas-project", running)
- Different training courses in Germany ("summer schools"), in Africa, Asia and South America

Contact addresses

Project coordination and Implementation



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“Advanced MERMAID System”

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Scientific Consultancy and Training



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