# SMART WATER GRID WITH S::CAN NANO::STATIONS – NEW TECHNOLOGY FOR FUTURE
# CASE STUDY: PROVINCE OF FRIESLAND, NETHERLANDS

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**Abstract**
This paper aims to present an innovative technology used to monitor in real time the water quality in Vitens which is part of the largest scale smart drinking water network in the province of Friesland, Netherlands. The technology was developed by S::Can, an Austrian company, a global leader technology one in on line spectrometry and available in the Romanian market by Tehnoinstrument company.
The Vitens initiative is part of the SmartWater4Europe project, which comprises 21 entities - water utility companies, technology companies and universities. More than 2200 km's of distribution network serving over 200.000 households in the Dutch province are currently fitted with 200 sensors that will measure the demand and quality of the drinking water in real time.
Eight s::can nano::stations have been installed at key locations of the network and were equipped with an i::scan, a pH::lyser and a condu::lyser. Data is transferred via 3G to the central office in Leuwarden which monitors the following parameters: turbidity, color, TOC & DOC, conductivity, pH.
The new technology used consists in the following:
i::scan - the new miniature multi-parameter spectrophotometer probe which will revolutionize online water quality monitoring: from very cost sensitive applications down to highly resolved "Smart Water Grids", in small unmanned plants, or even in single building protection. The new i::scan combines the high performance of a multi wavelength spectrophotometer with even lower costs than simple photometers!
By implementing this project, the water company was able to provide to its customers a very good water quality as Mr. Lieve Declercq, Chairman of the Vitens declared: "To us, this is a real game changer, we use the best and most innovative technology in order to create tomorrow's drinking water network…, we aim to be a water company that provides its customers with better service and information."

**Keywords**
Smart water grid, water sensors, water monitoring, water supply, event detection, early warning.

## 1. INTRODUCTION

**TehnoINSTRUMENT** has been present in Romania since May **1997**, with an operational focus on analytical process equipment.

The transition from the sale of equipment to the sale of solutions was achieved in **2000**, the year when the first continuous emission monitoring system was delivered.

The company **TehnoINSTRUMENT** has quickly become an important name on the equipment market in the following areas:

- Control of industrial processes;
- Gas and fire detection;
- Environmental quality monitoring;
- Research and laboratory.

**TehnoINSTRUMENT** has constantly built and expanded a competent and specialized team to provide associated services that complement the portfolio products:

- Basic engineering projects or execution projects;
- Assembling and/or commissioning;

- Warranty and post-warranty service;
- Complete user documentation and operating manuals;
- Training of operating personnel.

**TehnoINSTRUMENT** provides technical solutions that will respond as quickly as possible to the beneficiaries' needs regarding the efficiency, quality and safety of industrial processes and will integrate environmental protection norms.

**S::can Messtechnik GmbH** is based in Vienna, Austria with subsidiaries in USA, China, Spain, France, Mexico, Portugal, Italy and professional partners in the all globe.

**S:Can** is global leader in on-line spectrometry with more than 7000 spectrometer systems sold. Today offers a full range of water quality sensors and software: simple, easy to use sensors, terminals, software and networks for on-line monitoring and control of water quality and event detection. **S:Can** is serving the whole water industry from drinking water over environmental to wastewater (both municipal and industrial).

In partnership, **TehnoINSTRUMENT** and **S:Can** present you a study case in Netherlands, Vitens company as follow:

The Vitens initiative is part of the SmartWater4Europe project (https://sw4eu.com/), which comprises 21 entities - water utility companies, technology companies and universities. SW4EU contributes to the European Innovation Partnership on Water (EIP Water) by providing technology demonstration sites to accelerate integration of 12 SICT (Sensing Information & Communication Technology) innovative solutions which effectively respond to the industry priority needs and thereby enhance European SMEs' competitiveness and smart economic growth.

The objective of this project for Vitens was to obtain on-line measurement, allowing preventive actions in place of corrective (before end-customer claim, contaminations, any other).

## 2. TECHNOLOGY USED

Vitens is the largest drinking water utility in the Netherlands. The company is currently installing a large-scale smart drinking water mains network in the province of Friesland. More than 2200 km's of distribution network serving over 200.000 households in the Dutch province are currently fitted with 200 sensors that will measure the demand and quality of the drinking water in real time.

Eight s::can nano::stations have been installed at key locations of the network. Every nano::station monitors the following parameters:

- Turbidity
- Colour
- UV254
- TOC & DOC
- Conductivity
- pH

**Figure 1. Nano::stations installed**

A nano::station consists of a terminal for data and station management, and up to four sensors. For Vitens every nano::station was equipped with an i::scan, a pH::lyser and a condu::lyser. Data is transferred via 3G to the central Office in Leuwarden.

The nano::station completes the range of parameters in drinking water network monitoring, the traditionally measured parameters are Chlorine (Free and/or Total), Turbidity, pH, and conductivity. Chlorine is typically to be reported, while the others are to give an overall picture of water quality and eventual problems. With the i::scan, the much more interesting TOC can be added at a small additional cost, and the additional information's value is enormous.

All sensors come in one 4-channel flow cell, mounted on a panel at a fraction of size compared to conventional analyzers. The installation and start-up is plug-and-measure. Maintenance is close to zero. With this, the nano::station represents a totally new approach to distribution network monitoring.

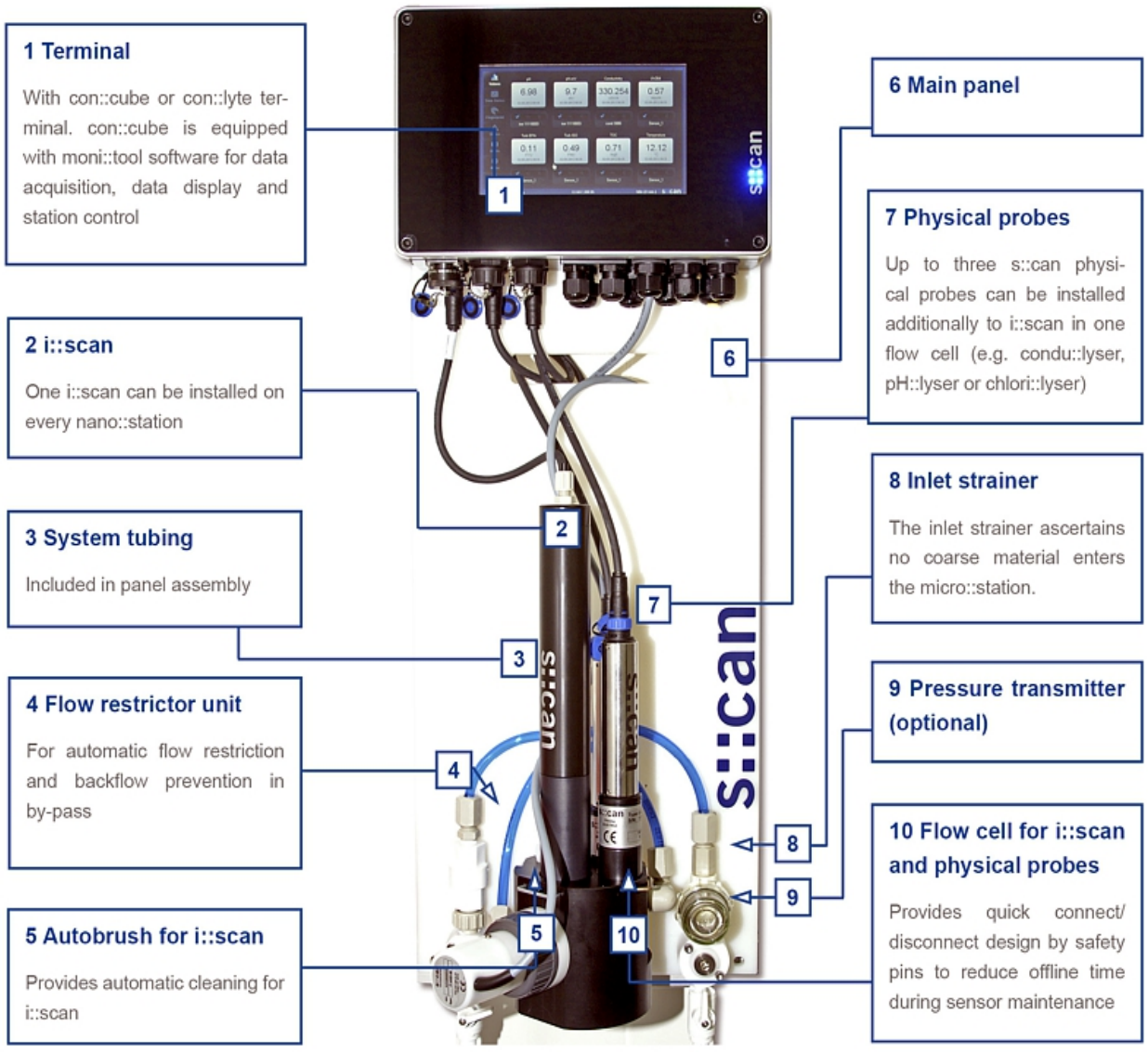


**Figure 2. The nano::station combines the i::scan with additional sensors for pH, chlorine and conductivity**

The new technology used consists in the following:

**i::scan** - the new miniature multi-parameter spectrophotometer probe which will revolutionize online water quality monitoring: from very cost sensitive applications down to highly resolved “Smart Water Grids”, in small unmanned plants, or even in single building protection. The new i::scan combines the high performance of a multi wavelength spectrophotometer with even lower costs than simple photometers!

The i::scan is a revolutionary and affordable spectrometer that uses the latest LED technology to measure the absorption spectrum.

**How does it works?**

s::can first introduced spectrometer probes for water quality monitoring back in the year 2000 and, having sold close to 5000 of those systems worldwide, is the far market leader.

The i::scan was designed around a miniature array of light emitting diodes (LEDs) as the light source. LEDs have many advantages over traditional light sources, as they are reliable, stable, small, and have low power consumption.

The i::scan utilizes the optical spectrum between 200 and 900 nm. Advanced optics allow the combination of a 180° spectral absorption measurement with a 90° light scatter measurement in a single instrument. This means that turbidity can be measured according to the ISO 7027 – 860 nm - and EPA 180.1 - white light - standard. The selection of the appropriate wavelength ranges have been optimized for measurement of popular water quality parameters in many types of applications. The algorithms for calculation of the parameters were designed based on the well proven algorithms that are used in s::can’s high end spectrometer probes.

The i::scan is extremely robust, using a high-tech polymer (PEEK), sapphire windows, and very resistant sealings. It can be exposed to any challenging waters including sea water. Due to the low power consumption, it can be powered by solar panels or batteries.

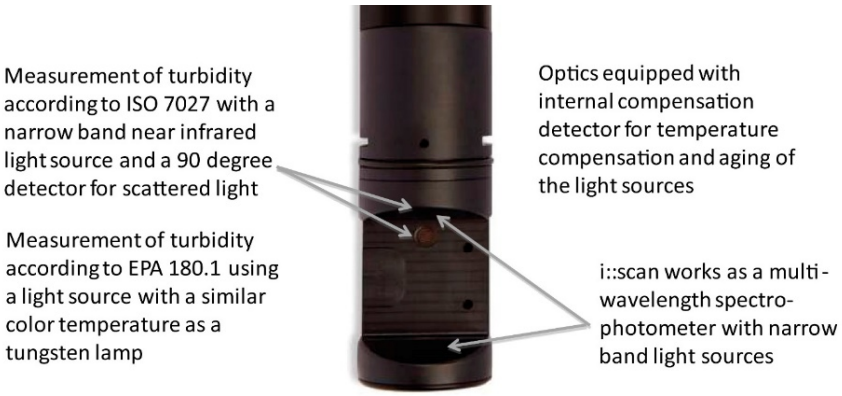


**Figure 3. Technology principle for I::Scan**

Combined Turbidity and Organics in One Device “Organic carbons” play an important role for evaluation of water quality. Parameters like COD or DOC picture an important portion of the matrix with respect to organic substrate, nutrition, pollution, and treatability. In many cases, the interesting portion of the organics will be present in the dissolved form, thus invisible for a turbidity sensor. A spectrometric DOC sensor like the i::scan, however, responds to most of these organics, from wastewater to finished drinking water.

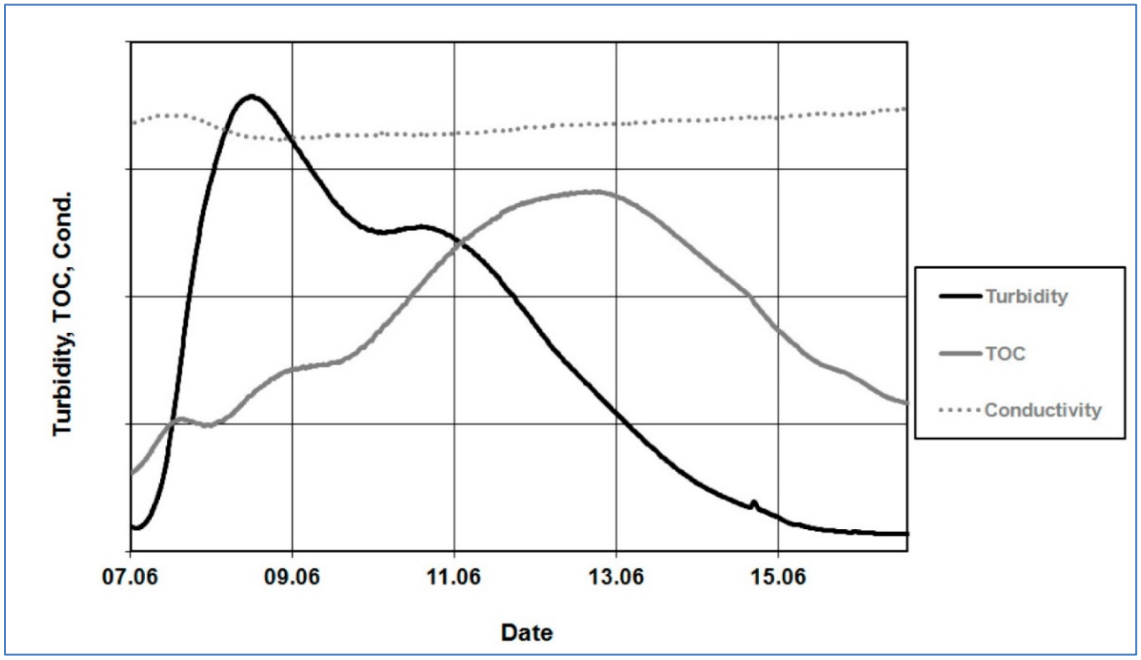


**Figure 4. The typical effect of heavy rainfall on river water**

As shown in Figure 4, the effect of heavy rainfall on spring water is elevated turbidity followed by elevated TOC, while no significant change in conductivity was observed. Reason for the popularity of light-scattering based turbidity sensors is not the diagnostic value of the parameter, but mainly cost limitations. The much more important dissolved and non-dissolved organic parameters have not been affordable to be monitored, until today. All this leads to the conclusion that a good monitoring system should combine both organics and turbidity, if only affordable.

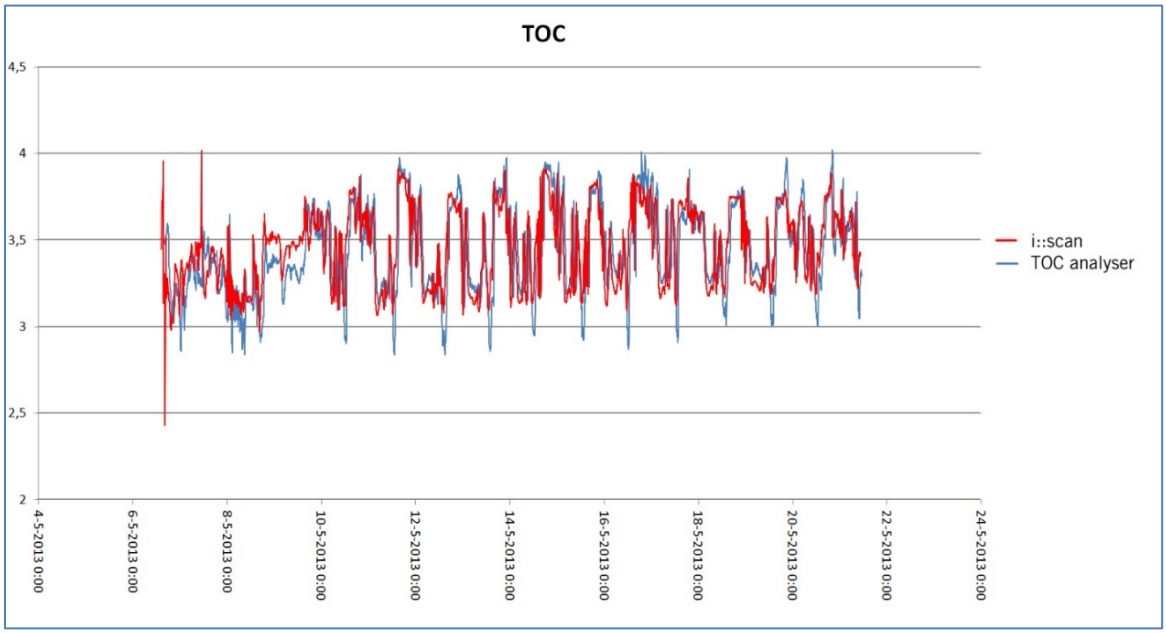


**Figure 5. Measurement results of the i::scan absolutely keep up with those of traditional TOC analysers that cost 5 times more and requires high maintenance**

### i::scan Installation & Cleaning options

There are three different installation options: The i::scan can be mounted submersed in the water, or in a flow cell (bypass installation), or directly in a pipeline of almost any diameter.

For latter, there are two different fixtures available: A simple version (Figure 6, left) for smaller diameters, and a “hot-tappable” version (Figure 6, right) for large mains pipes. The hot-tappable fixture contains a shut off valve, which enables to remove the sensor for maintenance without interfering with the pipe flow, and a drainage pipe that can also be used to connect an acoustic “spy” for leak detection.

The i::scan in-pipe fixture allows for measurement directly in the medium without any bypasses (cold or hot tapping possible). The in-pipe fixture has been designed and tested to work with a pressure of up to 10 bar. It contains a shut off valve that enables to remove the sensor for maintenance without interfering with the flow of the mains.

**Figure 6. The i::scan can be mounted directly in a mains/pressure pipe**

Depending on the water quality, the measurement windows of the i::scan need to be cleaned from time to time. This can be done automatically either connecting pressurized air (in waste water) or via a rotating brush (in clean waters). By doing this, the i::scan can be operated drift free for many months.

The i::scan is the ideal device for multi-point water quality networks. In such environment, it can be directly connected to any kind of SCADA network, data loggers, or other devices via RS485, or, coming soon, via the internal I.P. and web server to the cloud or smart phones.

### S::Can Software - Moni:tool

There is a revolutionary new platform for the management for an almost unlimited number of stations, on-line sensors, analysers and parameters.

Smart-phone-style, intuitive touch interface allows intuitive operation of sensor and station by non-expert staff.


**Figure 7. Moni::tool software**

Moni::tools is a software which can be used in a small monitoring station as well as in the heart of a large central data collection system, large local database for collection and management of all incoming data, can assure quality controlled and documented status management of probes and stations eliminate the need for paper log books.

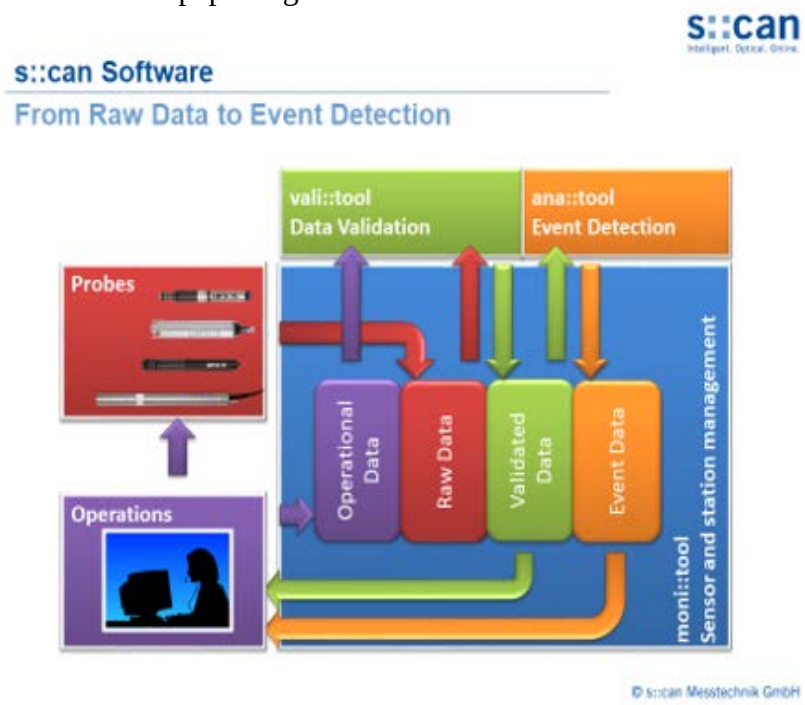


**Figure 8. Steps to see Event Detection**

One of the most important applications for Smart Water Grids is systems for „Event Detection and Early Warning“.

As it is shown in Figure no. 8, the additional module for the software are available to obtain event detection. The Vali::tool validates data and ensures only high quality data are fed into the event detection module and Ana::tool identifies unknown and unusual conditions and triggers alarms.

## 3. CONCLUSIONS

1. Smart Water Quality Grids - The i::scan is the ideal device for multi-point water quality networks. In such environment, it can be directly connected to any kind of SCADA network, data loggers, or other devices via RS485, or, coming soon, via the internal I.P. and web server to the cloud or smart phones.
2. Opinions:
   "The installation of a grid of water quality sensors will allow us to actively manage our water supply distribution networks based on real time status data.", Says Erik Driessen, innovation manager of Vitens.
   "To us, this is a real game changer", Lieve Declercq, Chairwman of the Vitens executive board, explains, "we use the best and most innovative technology in order to create tomorrow's drinking water network. This enables us to proactively solve problems before anyone experiences any problems in the drinking water supply. Ultimately, we aim to be a water company that provides its customers with better service and information.".
3. Applications:
   One of the most important applications for Smart Water Grids is systems for „Event Detection and Early Warning".
   "Be able to detect and respond to any kind of event in real-time, and be able to immediately identify the response of the water system to take action on the water quality map".
4. Technology:
   S::can is the best in performance in terms on reliability and number of deliverable parameters. Official statement will also be soon published in official web-site.

## 4. BIBLIOGRAPHY

[1] Smart Water 4 Europe Project: https://sw4eu.com/.
[2] S::Can internal documents and website www.s-can.at.