VAISALA

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Vaisala in Brief

Vaisala is a global leader in environmental and industrial measurement. Building on 80 years of experience, Vaisala contributes to a better quality of life by providing a comprehensive range of innovative observation and measurement products and services for chosen weather-related and industrial markets. Headquartered in Finland, Vaisala employs approximately 1,600 professionals worldwide and is listed on the NASDAQ Helsinki stock exchange.

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Breaking New Ground – Again

For us at Vaisala, exploring new areas and looking for new opportunities has always been in our DNA. Ever since Professor Väisälä designed the first radiosonde, we have strived to push the envelope and break new ground.

This innovation spirit is also evident in the light of our recent developments.

One of the biggest R&D projects in Vaisala's history has led to the development of a new dissolved gas analysis monitor, which we launched this spring. This exciting new product is vital for energy transmission as it helps detect developing faults in power transformers, and even helps in preventing total failures.

In our life science business, the new viewLinc system makes it possible to monitor conditions at considerable distances, in spaces where wireless connections have been impossible so far.

Recently, we have also introduced new products and technology to expand our offering in the growing air quality monitoring market. With the help of affordable technology, more dense measurement networks can be built, and authorities, businesses and citizens will be able to get local, real-time information on air pollution.

And we are looking into connected cars to see how our weather sensors could be utilized in the intelligent traffic of the not too distant future.

What do these achievements have in common?

In each case, we have found a possibility to exert our cutting-edge expertise to solve a real-world problem. We have listened to our clients to find out their needs and wants, and done our best to meet and surpass them.

This requires genuine interest and enthusiasm, in addition to expertise. Magic happens when this sentiment is shared with customers and research partners. At Vaisala, we are fortunate to have demanding customers, who often use our products in mission critical parts of their operations.

And behind all this, is our desire to make the world a better place for all of us – by providing snowfall information for airports to keep runways safe, by monitoring transformers and keeping the electrical grid working, or keeping art treasures in good condition for future generations.

Making a better world – one measurement at a time!

Kjell Forsén
President and CEO

Taking a Step towards Improving Air Quality

To mitigate the effects of air pollution, and to forecast it, it has to be measured first. Affordable instruments are needed to make the observation networks comprehensive enough to make a real difference.

Pollution and particles in the air are a growing concern and a real health risk, leading to millions of premature deaths each year.

In western industrialized countries, air quality has improved consistently in the last decades, but at the same time, awareness of health risks related to air quality has grown. In emerging countries, pollution is unfortunately still on the rise.

Real-time Information from Denser Networks

To do its part in mitigating the problem, Vaisala launches new affordable products that will help build denser observation networks, to provide more comprehensive and accurate information about air quality.

"Air quality is an area where observations can truly improve the lives of all people. Without reliable, affordable, accurate and extensive measurement networks it is difficult to improve the situation," says **Erkki Järvinen**, Head of Vaisala's air quality business.

"Without local information, people cannot have real-time visibility to their exposure to polluted air and to make real-time decisions regarding it," he continues.

Traditionally, air quality monitoring has been the domain of the authorities and has required regulatory measurement stations. These, however, are quite costly, so the networks built with are too sparse to indicate local pollution levels accurately. In a city the size of Beijing, there are only about 50 air quality measurement stations.

This has created a need for supplementary air quality monitoring: dense but cost efficient measurement networks that increase the number of measurement points and improve the access to real-time air quality.

Enabling New Applications

The dense networks can provide information not only to the authorities and decision-makers, but also businesses and citizens. This information can be used in the development of new services.

For example, once the networks are dense enough, it would be easy to create an application for bike commuters, telling them which route to take to keep their exposure to air pollutants to a minimum. Or ventilation in offices could be adjusted according to the air quality outdoors. Such dense grid would enable citizens to evaluate and also minimize their daily dose for pollutants. The possibilities are exciting.

For Vaisala, expanding its offering on the air quality monitoring market is a natural extension to its weather business. The new products can be connected seamlessly

to the WXT weather transmitter to get a more comprehensive picture of the situation.

Weather effecting the air quality is a well-known matter. Dependence works also to the other direction: air quality affects the weather. If, for instance, sunshine cannot penetrate a layer of air pollutants, temperature will not rise as high as the weather forecast indicated.

This is one of the reasons why the trend is towards micro weather forecasts that can detect fluctuations between different parts of a city.

Proprietary Technology

Vaisala acquired proprietary technology and products in August. The products measure pollution gases, like carbon monoxide, nitrous oxides, sulfur dioxide, hydrogen sulfide and ozone, as well as particles in the air.

The gas measuring is based on advanced technology that enables parts per billion measuring at an affordable price. The gas analysis module compensates the impact of internal and ambient conditions on the sensor elements with sophisticated algorithms and active environmental control to achieve performance that is far better than that of competitors.

The operating principle of the particle sensor is based on scattering caused by particles moving past a laser beam; the particles are detected with the help of optics and photosensitive sensors. The method allows simultaneous measurement of two particle sizes.

The products can be built into comprehensive air quality monitoring networks which provide specific information on where pollution is generated and which areas are influenced by it. They can also be used as instruments that supplement the data provided by reference measurement stations.

AIR QUALITY TRANSMITTERS AQT410 AND AQT420

AQT410 and AQT420 are both cost effective solutions to monitoring air quality. They are the first air quality transmitters for ambient air. As compact and stylish devices, they blend in well in urban environments, or they can be used in industrial areas.

The devices measure up to four most common air pollutants. These can be volatile organic compounds, carbon monoxide or dioxide, nitric or nitrous oxide, sulfur dioxide or ozone,

The AQT420 also includes a particle counter.

The measurement data is sent wirelessly to a web-based database, or accessed locally via a serial interface.

Their applications include e.g.:

- urban air quality measuring networks
- smart building automation
- roadside monitoring
- monitoring point emission sources
- industrial emission monitoring
- research applications

LASER PARTICLE COUNTER AQM100

AQM100, one of the smallest particle counters, is designed primarily for indicative particle matter measurements.

In the standard setup, the device measures particles of under 2.5 micrometers and under 20 micrometers in size, but other particle sizes are available on request.

Jarkko Sairanen, Eero Alkkiomäki and Erkki Järvinen are ready to enable real-time visibility to exposure to polluted air, and to help make real-time decisions regarding it.

Careful design, process controls, and the expertise of the cleanroom personnel makes Vaisala's cleanroom operation efficient.

Cleanroom Expertise Makes Sensors Stable Enough for Space

by Tomi Salo, Principal Scientist in Vaisala

Producing sensors that can pass the extremely rigorous tests space exploration equipment is subjected to is no easy task. For Vaisala, this is business as usual.

On March 2016 the European Space Agency (ESA), in cooperation with the Russian Federal Space Agency Roscosmos, launched a new mission to Mars. It is estimated to reach Mars in October 2016.

The landing module of the spacecraft carries a small environmental observation station. The sensing instrumentation is provided by the Finnish Meteorological Institute (FMI). The station, designed and tested by ESA, uses a suite of sensors to monitor systems on the module and gather data on environmental conditions, such as wind speed and direction, humidity, pressure and surface temperatures. Sensors used to gather data include humidity and pressure sensors designed and manufactured by Vaisala.

From Earth's Cleanroom to Interstellar Study

Typically used for industrial or meteorological applications to measure a range of parameters, Vaisala sensors

measure dew point, humidity, pressure, temperature, and gas concentrations. The pressure and humidity sensors currently used in space exploration can function under the harsh conditions in large part because of their stability.

Along with sensor design and calibration, the most important factor to ensuring sensor stability is the quality of the cleanroom facilities in which the sensors are manufactured. Like all cleanrooms, the efficacy of Vaisala's cleanroom depends heavily on careful design, process controls, and the expertise of the cleanroom personnel.

Cleanroom Design Aided by In-house Equipment

There are several factors in the cleanroom that contribute to sensor robustness and stability. Cleanroom design is the first, most obvious fact. However, unlike most cleanroom facilities, and by virtue of the sensors it manufactures, Vaisala can use its own devices to measure its cleanroom conditions. Vaisala's other cleanroom equipment is also designed fit for purpose; tightly specified for how it is used. A feedback control system ensures the environment is reliably controlled.

Along with measuring cleanroom conditions with its own measurement devices, Vaisala has another special feature that allows the company to customize sensors for space exploration: low volume. Vaisala manufactures about 1.5 million chips annually. The production equipment is intended for high mix – low volume manufacturing, meaning smaller wafer size and smaller batches than volume-based cleanroom facilities. Thus, small changes and variations can be applied to standard processes and products to tailor sensors for very limited limited purposes.

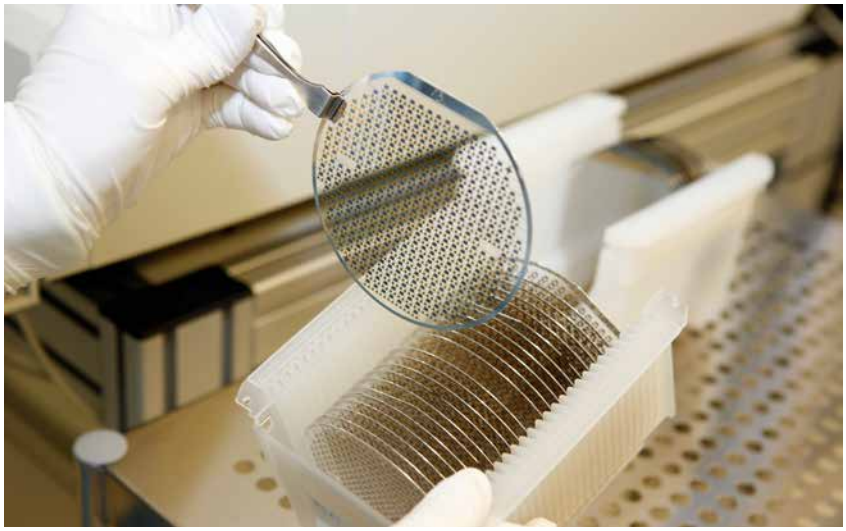
Manufacturing low volumes in small batches also allows staff to continually learn from processes, making tools like Statistical Process Control more meaningful. In the case of the capacitive thin-film polymer humidity sensors, manufacturing the chips takes a few weeks, whereas other sensors can take up to several months. Statistical Process Control ensures high quality over long lead times, and sensor materials and structures undergo dozens of tests.

The Key: Longstanding, Expert Cleanroom Operators

Highly motivated and well-trained people are probably the single most important factor to Vaisala's cleanroom effectiveness. With many different cleanroom technologies available, the human element can be forgotten. But, in Vaisala's case, expertise has been critical to the company's ability to create pressure and humidity sensors that can withstand the conditions of space travel and exploration.

Vaisala may be rare among manufacturers in that most of its cleanroom personnel have fifteen to twenty years' experience. A relatively small group, the cleanroom operators overlap in their competencies, allowing them to shift roles when needed. This keeps skills sharp and the work dynamic and interesting.

The majority of the processes have been automated. However, as Vaisala sensors are manufactured in small batches, there are also several manual processes as part of production. For instance, operators manually load wafers into a machine, or perform time-based etchings; a skill that takes time to learn and refine. This sort of manual work in combination with long experience has endowed the staff with instincts that allow them to spot even minute changes in output. Experienced operators train new staff on the "silent knowledge" of their cleanroom processes. With the human element, the cleanroom work is in many ways as much craftsmanship as science.



Vaisala's humidity sensors. Similar sensors are used in space research by NASA and European Space Agency ESA.

To Mars and Beyond: A History of Vaisala in Space

Space continues to fascinate the human consciousness, you only have to look at the success of 2015's Star Wars: The Force Awakens for evidence of that. Here at Vaisala, our interest in space extends beyond science fiction.

Vaisala sensors are currently being used in the European Space Agency's ExoMars Mission that was launched in 2016, which has sent spacecraft to Mars in order to assess the planet's environment and pave the way for future exploration, and the Mars Curiosity Rover, which has already made a number of groundbreaking discoveries on the Red Planet.

These are not the only occasions on which Vaisala technology has gone into space, as we have a long history of providing sensors for space exploration, dating all the way back to the 1950s.

Why Go to Mars?

ExoMars is the 44th attempted Mars Mission, with the first a failed Soviet attempt back in 1960. Since then, 23 missions have reached the Red Planet successfully, with Vaisala technology used in several of these. For example, our sensors were part of the Mars Rover Curiosity mission, which discovered the first evidence of liquid water on Mars in 2015.

What do we stand to gain from investigating space? There are a number of factors that make investigating planets such as Mars worthwhile. Exploring space fosters innovation and international collaboration, brings us closer to knowing whether life away from Earth and satisfies human's innate desire to explore and understand the world around us.

Investigating Mars is particularly important, as the planet's similarities to Earth could help us better understand the challenges we face here on Earth such as climate change.

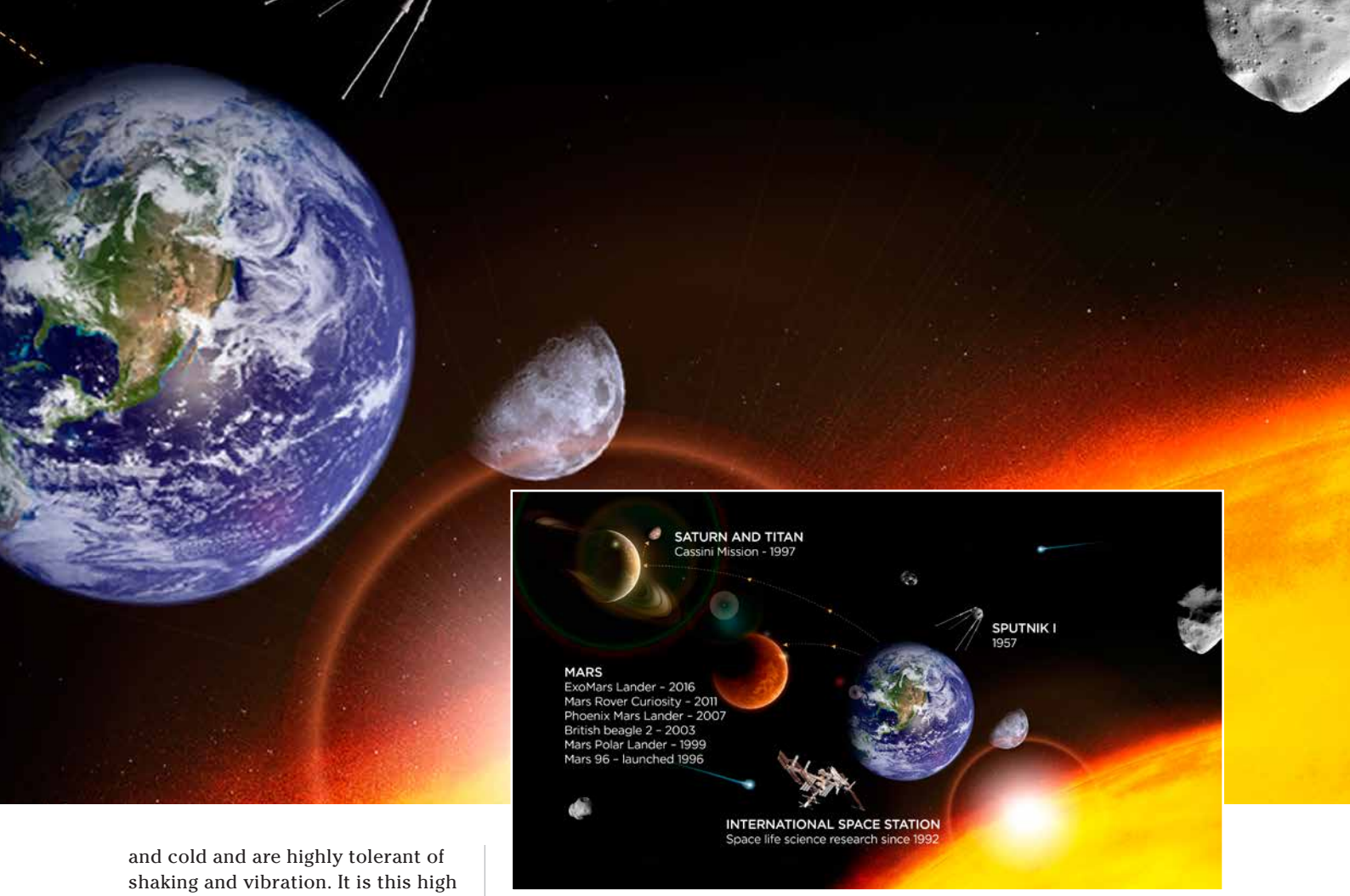
This has been highlighted by **Ari-Matti Harri**, head of the radar and space technology research division at the Finnish Meteorological Institute (FMI) - a long-term partner of Vaisala - who stated: "By studying the simplified, dynamically Earth-like, atmosphere [on Mars] we can potentially learn something that we might miss on Earth because of the effects of water systems, vegetation, and high humidity levels."

Missions to Mars have already yielded a number of important discoveries. We now know that the planet's climate has altered dramatically over time, while the discovery of water on the planet - aided by Vaisala technology - has a significant bearing on the possibility that it once, or perhaps even still does, support life. It has also been revealed that radiation levels on Mars do not pose a significant health threat to humans, keeping the possibility of manned exploration of the planet open in the future.

Vaisala on the Red Planet

How exactly is Vaisala helping to explore space? Since the 1990s, our barometric pressure and humidity sensors have been used in missions to Mars and beyond, helping scientists gain insight into the atmosphere to better understand outer space and whether planets like Mars have ever, or still do, support life.

Why is Vaisala technology utilized in space exploration? Our technology is extremely stable and this is vital due to the extreme environmental conditions that are experienced in space. Vaisala sensors are able to withstand extreme heat



and cold and are highly tolerant of shaking and vibration. It is this high level of stability that ensures they can deliver accurate readings of the real changes taking place in the environment on other planets.

From Sputnik to Saturn

At Vaisala, we are proud to have been involved in space exploration since its beginnings in the 1950s. Back in 1957, we converted the frequency of a radiotheodolite to help track Sputnik I, the world's first artificial satellite, the launch of which represented a pivotal point in the history of space exploration.

Since then, we have been involved in a number of fascinating missions, providing technology to help understand the universe around us.

Mars Rover Curiosity

Vaisala provided the FMI with pressure and humidity sensors for the Mars Rover Curiosity that was launched in 2011, representing the fifth venture into space since the organizations first partnered in 1998. In 2015, the Rover Curiosity found the first evidence of liquid water on Mars, representing one of the most significant discoveries made on Mars to date. The mission has also discovered that Mars once contained the chemical elements, such as sulfur, nitrogen, oxygen, phosphorus and carbon, needed to sustain life as we know it. Furthermore, it has provided details of the planet's radiation levels, which will prove vital information for any future manned missions.

The rover is still active on the Red Planet and the mission, which was originally scheduled for just two years, has been extended indefinitely, with NASA saying it has the potential to continue providing data for 55 years. The launching of another rover is planned for 2020.

Phoenix Mars Lander

In 2007, the FMI contributed a pressure measurement instrument based on Vaisala sensors to the University of Arizona-led Phoenix Mars Lander mission. The project was the first successful landing in a Martian polar region and provided scientists with a number of insights into the climate and geology of this part of the planet.

Among Phoenix's discoveries were the presence of snow and ice at Mars' pole and the presence of the chemical perchlorate, which is used as food by some bacterial lifeforms on Earth. Such discoveries provided a more detailed understanding of Mars' climate and weather, and further evidence that the planet may have supported life at some point.

Cassini Mission to Titan

Mars is not the only planet visited by Vaisala technology. Our pressure sensors were part of NASA's Cassini mission which was launched in 1997, and in 2005 achieved the first ever landing on a moon in the outer solar system: Titan, the largest moon of Saturn. This is one of the most ambi-

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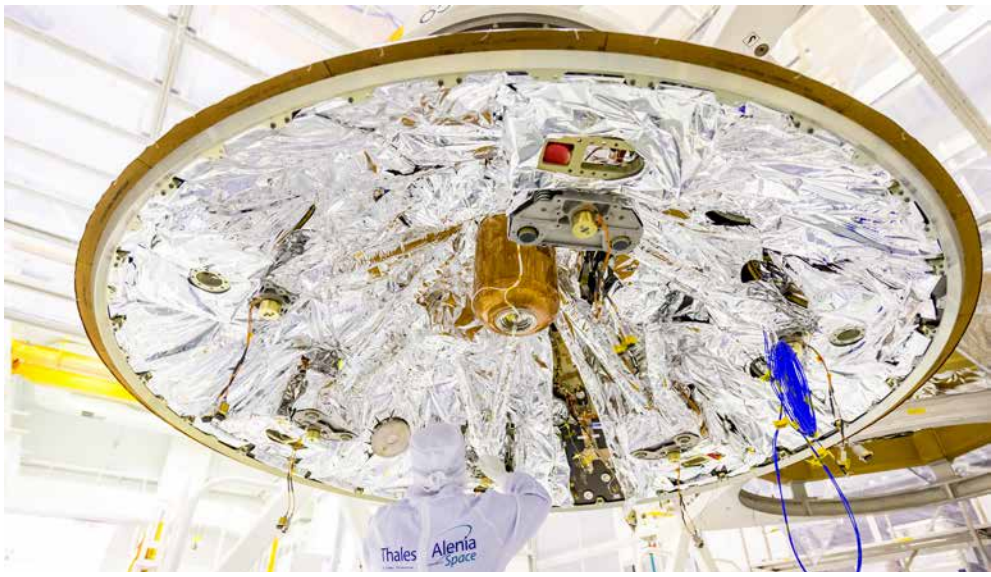
Vaisala humidity and pressure sensors are fitted on the small weather station onboard the landing module, Schiaparelli. Picture: Thales Alenia Space/Imag[IN]



tious missions ever launched into space and is still ongoing.

A number of fascinating discoveries have been made, including the presence of frozen water on Enceladus (another of Saturn's moons), the possible birth of a new moon orbiting Saturn and the existence of geologic processes similar to that of Earth on Titan. As the first mission of its kind, lessons learned from Cassini will have a huge influence on future attempts to explore the outer solar system.

Space Life Science Research

Since 1992, scientists at BioServe Space Technologies at the University of Colorado have been using Vaisala's carbon dioxide, humidity, and temperature sensors to control life science experiments both onboard space shuttle flights and at the International Space Station. This allows for the regulation of plant growth and animal habitat environments and the study of how they are influenced by microgravity. The findings of such research is vital in determining if food and life support consumables, such as water and oxygen, can ever be produced on board space shuttles, which is necessary if manned flights to Mars and long-distance space exploration are to become a reality.

Over the years, Vaisala's legacy sensors have been replaced with GMM220 series CO_2 modules and HMP110 humidity and temperature probes. However, the original sensors continue to deliver reasonable readings, which is testament to their stability and durability in extreme conditions.

Sometimes Learning is All You Get

Vaisala sensors have also been included in several missions that have not reached their destinations or the goals of the missions. In 1996, several Vaisala sensors were included in a Russian mission Mars96, which launched unsuccessfully. Highly ambitious at the time, Mars 96 aimed to assess the evolutionary history of Mars' surface, atmosphere, and inner structure. The technology used in the project has influenced a number of subsequent missions, including the ongoing Mars Express, which is the second longest surviving, continually active spacecraft in orbit around a planet other than Earth.

Three years later in 1999, four pressure sensors and Vaisala thermocaps were included in NASA Mars Polar Lander. It reached Mars successfully, but failed on landing. Several of the instruments developed for this mission were later utilized in the Phoenix Mars Lander mission.

In 2003, a mission called British Beagle 2 had Vaisala's pressure sensor, thermocap and Capic circuit onboard. It reached Mars, but suffered a communications failure. Features of the spacecraft's design have since been proposed for a number of other potential Mars missions.

What Might the Future Hold?

At Vaisala, we are proud to have supported space exploration efforts for the past 50 years. A number of missions are planned between 2018 and 2020, including the second stage of ExoMars, but what might the future hold for the science? It is hoped that these projects will pave the way for eventual manned missions to the Red Planet, which would then open up a whole host of new opportunities ranging from establishing a permanent colony to mining the planet's mineral resources for use on Earth.

Whatever the future holds for space exploration, Vaisala will continue lending our expertise and providing sensor technology that helps to unlock the secrets of the universe around us.

ExoMars to Reach Mars in October 2016

The latest Mars mission is called ExoMars, and it is realized jointly by European Space Agency (ESA) and Russia's Roscosmos. Launched in March 2016, it has already travelled a majority of its nearly 500 million km journey to Mars. It should reach its destination on October 19, 2016.

RainMiner Helps Harvest Rainwater

Rainwater goes down the drain even in places where water is scarce. With their RainMiner solution, Vaisala's Weather Data Challenge winners want to help change this.

Many places around the world do not have ready access to water, but have a lot of rain. This rainfall could be harvested and put to good use.

The RainMiner tool can be used to assess the availability of rainwater at a given place with the help of open data from precipitation datasets. Moreover, RainMiner provides advice on what kind of a system is best suited to harvesting rainwater and how much it would cost to set up and run.

"In places like Mexico City, where water scarcity is a growing issue, the plentiful local rainfall could be used to cover the water demand of millions of people at least partially," says **Paulina Concha Larrauri** from the winning team.

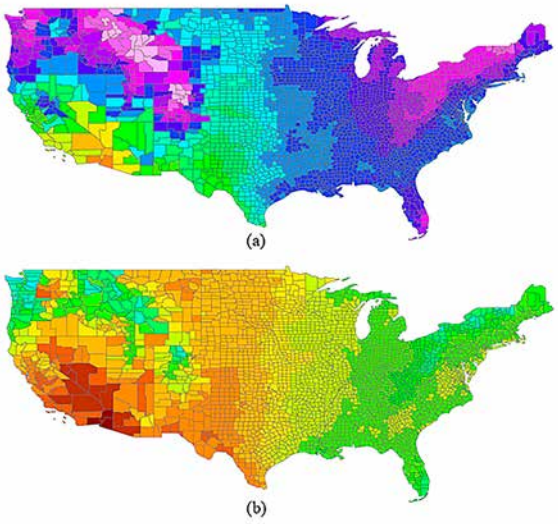
Another good example are the favelas in Brazil, which may not be connected to water mains at all. Favela Moros dos Cabritos in Rio de Janeiro has been one of the RainMiner testing sites.

"Our goal was to look at rainwater harvesting from a regional perspective by exploring its applicability as a water resource, similar to the way that solar and wind energy are disrupting the standard electricity grid," explains **Mounir Ennenbach**.

The two Columbia University graduates are both from dry areas: Larrauri from Guanajuato in Mexico and Ennenbach from Jordan. Larrauri currently works at the Columbia Water Center, and Ennenbach works at Citigroup as an Environmental Risk Analyst.

Vaisala's Open Weather Data Challenge started in November 2015 and ran till the beginning of March 2016. Out of 23 entries, RainMiner won the 20,000 euro first prize.

More information:
vaisala.com/weatherchallenge



Tapping into the Power of Community

Arranging the Open Weather Data Challenge has given Vaisala a unique opportunity to see how people around the world would tap into open weather data.

Students, meteorologists, software developers, weather enthusiasts and other companies were invited to share their solutions for some of the issues facing society. The entries were judged based on novelty, potential for impact on weather-related issues and their feasibility.

"The challenge has made us better known in the start-up community, raised our profile among software developers and provided a good understanding of ideas around the open weather data. The experiences have been so good that we will utilize open innovation also in the future," says **Ilkka Mannonen**, the Head of Weather Offering.

The Challenge also goes to show that open data and the power of community can create feasible concepts, like the RainMiner, that have the potential for true impact on business and on our lives.

Efficient Transformer Monitoring Improves Power Industry Performance

Power transformers are critical in the energy generation and transmission, but also one of the key vulnerabilities. A transformer downtime will lead to substantial financial losses and to energy shortfalls for national grids. Furthermore, cutting costly false alarms and increasing the reliability of dissolved gas analysis (DGA) will be crucial to tackling long-term maintenance budget overruns and boosting asset performance. Optimus™ DGA Monitor is Vaisala's latest invention, answering to the measurement challenges in transformer monitoring.

Power transformers play a vital role in electric energy transmission, stepping up the electricity voltage for transmission, and respectively stepping it down at the receiving end. Like any electric devices, which are subjected drastic voltage changes, harsh weather conditions and general wear and tear, they also need maintenance to be kept in shape. Sudden breaks, repairs and replacements can take months, greatly increasing business interruption costs caused for the utility companies.

The financial severity of transformer failure is well known to the industry. An extensive service costs more than €100,000, while a replacement transformer can cost up to €4 million. Associated loss of production can further increase these figures.

Efficient condition monitoring is one of the only means of proactively mitigating the risk of transformer downtime. One of the methods is dissolved gas analysis (DGA), which is commonly used for assessing large power transformers.

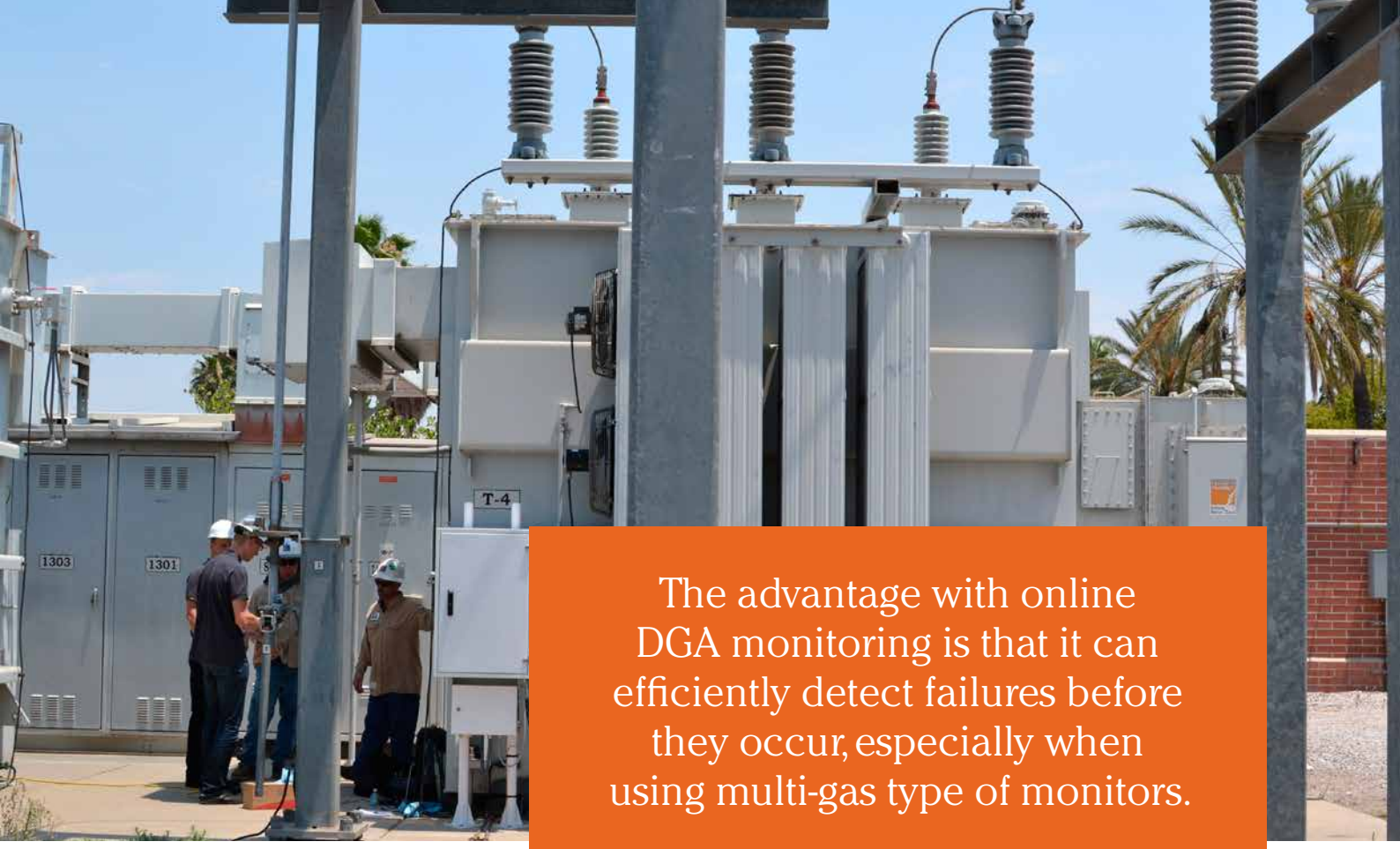
Reducing the Probability of Error with Online DGA

Especially online DGA condition monitoring is becoming standard practice for aging transformer fleets. It enables proactive diagnosis and mitigation of developing faults before they lead to costly downtime.

However, there is still scope for improvement to their reliability and cost-effectiveness. Streamlining monitoring procedures and reducing the probability of errors is highly important. False alarms from on-site DGA systems and errors during routine oil inspections still pose challenges for utilities, disrupting maintenance schedules and generating unforeseen costs. In addition, the need to validate on-site data via regular laboratory sampling increases the complexity and duration of the testing process.

"The advantage with online DGA monitoring is that it can immediately detect any abnormal gas formation. While it is more expensive in the short term, in long-term it is cheaper, compared to manual sampling, since it can more efficiently detect failures before they occur, especially when using monitors of the multi-gas type," said Dr **Michel Duval**, a world-renown leader in the field of DGA, speaking to Vaisala about transformer monitoring procedures.

"Rigorous condition monitoring via online DGA is the only way to proactively keep on top of trans-



The advantage with online DGA monitoring is that it can efficiently detect failures before they occur, especially when using multi-gas type of monitors.

former performance – particularly as the operational transformer fleet ages," said **Juhani Lehto**, Product Manager at Vaisala. "However, the data collected must be dependable, if we are to detect all potential faults in advance, or reliably determine whether it is worth sending out a maintenance and inspection team."

Fully Dependable Real-time Monitoring

Vaisala's plug-and-play Optimus™ DGA monitor can be installed in two hours, and uses partial vacuum gas extraction to provide a fully representative sample of all dissolved gases in the transformer oil. Readings taken by the built-in infrared sensor are unaffected by oil temperature, pressure or type, and the system regularly auto-calibrates to provide fully consistent and dependable data. This data is available via an online interface, allowing continuous, reliable, real-time analysis of transformer performance – without false alarms.

Dr Michel Duval sees that in the not-so-far future, online DGA monitors will be deployed as standard equipment on all large transformers. That, in turn, will open the door to automated monitoring of the grid and, ultimately, the development of smart grids with computer-assisted decision-making.

Vaisala Optimus™ DGA Monitor was installed in the sunny California, USA, in under two hours.

Moving You Forward

The role of weather sensors in intelligent traffic and the roads of the future

The world is becoming increasingly connected. Thanks to advances in information and communications technology, the cities we live in are becoming 'smart', with everything from education to law enforcement managed by integrated tech solutions in a bid to improve quality of life.

Changes to transport and the way we get around will be a pivotal part of the development of true smart cities. From cars that exchange information about traffic to vehicles that drive themselves autonomously, the roads in the cities of the future could be quite different to those we see today.

For this future to become a reality, the collection of accurate weather data collection will be key. Aside from human behavior, weather is the single most import factor that influences traffic and road safety, meaning this information will be a fundamental part of the development of smart cities.

With more than 40 years' experience of fixed and mobile road weather data collection, Vaisala is at the forefront of the ongoing progression of this exciting technology that is helping to shape the cities of the future.

Intelligent Traffic and Connected Cars

According to Gartner, there will be 250 million connected vehicles on the road globally by 2020. The organization defines a connected car as a vehicle that has some form of in-built wireless network connectivity, which can be used for functions as diverse as streaming music online to providing drivers with real-time traffic and congestion information. This technology is already available, with figures from Statista showing connected cars currently account for 12 per cent of total vehicles. This share is expected to almost double to 22 per cent by 2020, as connected vehicles become more affordable in the next few years.

While connected cars will provide numerous features for improving in-car entertainment and safety, their biggest contribution to the development of truly smart cities will be intelligent traffic. Road congestion is a problem in urban areas the world over, creating pollution, damaging the environment and generally inconveniencing people's daily lives. Cars with in-built connectivity will help to alleviate this issue by interacting with intelligent transportation systems that provide drivers with real-time information. These vehicles will not only be able to receive data, but share it too, facilitating an exchange of data that allows city roads to become much more efficient. For example, in the US, technology has been trialed that will prompt drivers with the option of paying to enter a carpool lane if they are about to drive into a congested area. Meanwhile, in China, there are plans to develop a system that can monitor the number of vehicles in one area and divert cars away if capacity is close to being exceeded. This way, traffic jams are avoided before they occur.

If traffic is to be successfully managed in this way, access to accurate weather data will be pivotal. Research from the US Federal Highway Administration (FHWA) shows light rain or snow can reduce traffic flow by as much as 13 per cent, while the figure is up to 17 per

If traffic is to be successfully managed in this way, access to accurate weather data will be pivotal.

cent and 64 per cent for heavy rain and heavy snow respectively. With weather conditions having such a significant impact, any intelligent traffic solutions will be reliant on accurate weather data if they are to predict and manage traffic flow accurately.

Most modern cars already contain basic weather sensor technology that allows for the measurement of temperature and for traction control. More advanced sensors are only currently seen in commercial fleet and government vehicles, but, as connected cars become commonplace and the drive towards smart cities continues, such technology may become readily available in consumer cars, allowing for the exchange of reliable baseline weather data needed to manage traffic intelligently and efficiently. Should this be the case, the highly accurate data provided by roadside weather stations will remain key, with the added data provided by connected cars helping to fill in the gaps that currently exist.

Autonomous Cars: the Next Step

Connected cars will be just the start. The next step in the evolution of our roads is autonomous vehicles - cars that are capable of driving themselves. For a long time, such technology has been limited to the realms of science fiction, but, with each passing year, driverless cars are coming closer to reality.

A number of companies are investing heavily in this space. Tesla has already its 'autopilot' software update, which uses cameras, radar, ultrasonic sensors and mapping data to allow cars to "automatically steer down the highway, change lanes, and adjust speed in response to traffic". Tesla's approach to autonomous vehicles is a gradual, aiming to steadily introduce new features that remove the need for drivers to carry out certain functions. The autopilot function can only be engaged once the car is already moving at a relatively constant speed, has a sense of the cars around it and a map of the area it is traveling through. Other companies, such as Google, are focused on delivering a fully autonomous car from the start. The tech giant's autonomous cars have already covered more than 1.5 million miles in test runs in the US, although safety drivers have always been aboard to date.

While there are exciting developments taking place, there has, so far, been limited discussion about the role weather sensors will play, other than admissions that bad weather presents one of the main obstacles autonomous vehicles will need to overcome. This technology is

Autonomous vehicles will require the ability to assess and adapt to conditions if they are to navigate our roads safely.

essential if self-driving cars are to ever become a reality on our city streets. With weather having such a dramatic impact on traffic - 22 per cent of road accidents are weather-related, according to the FHWA - autonomous vehicles will require the ability to assess and adapt to conditions if they are to navigate our roads safely.

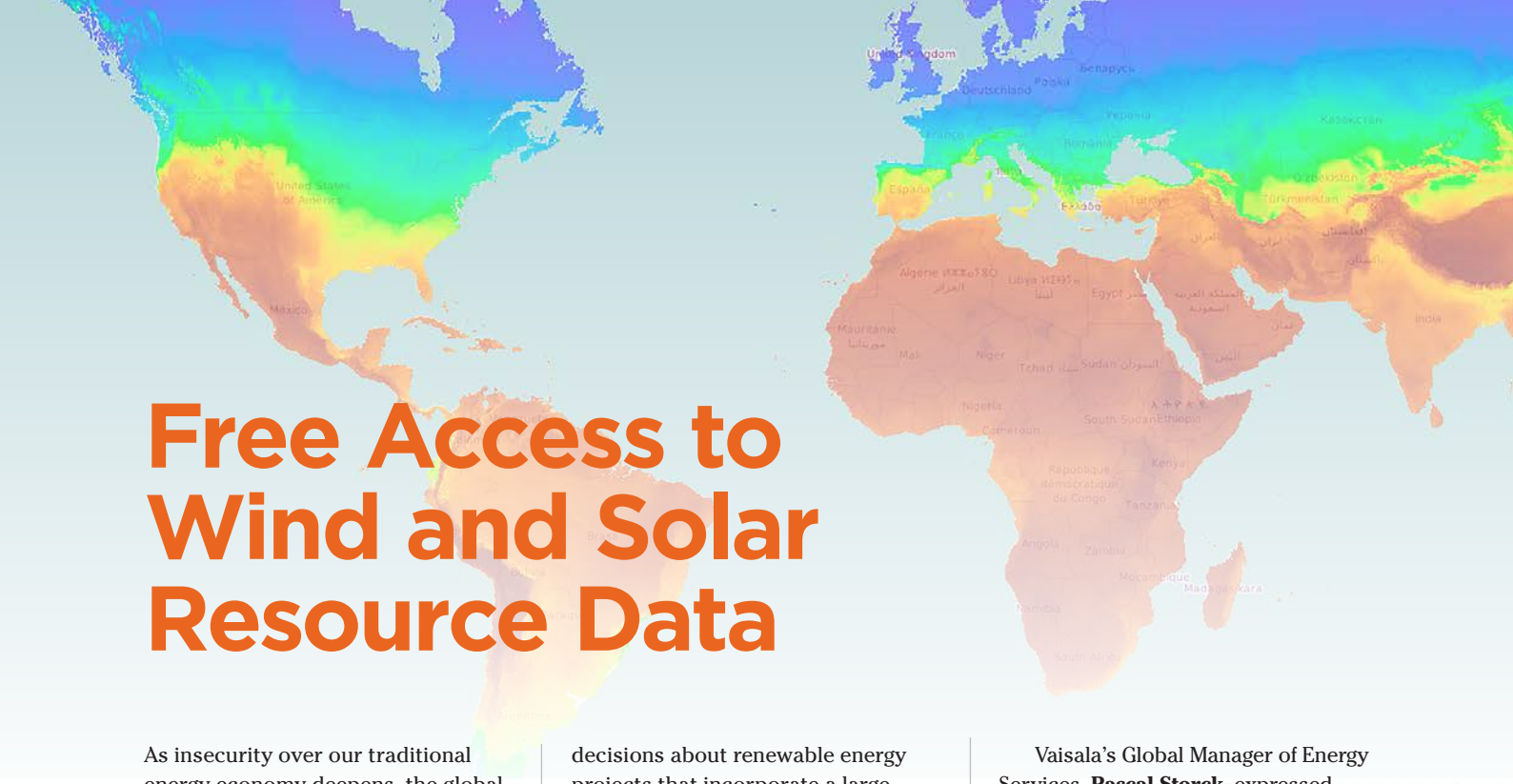
A human driver is able to observe weather conditions and adapt their driving behavior accordingly, although this often isn't enough to avoid accidents, as the FHWA figures show. If autonomous vehicles are to be able to do the same, accurate and reliable weather data will be key. Cars will require the ability to receive and process data and then interpret it to ensure they are driving safely. Only with reliable and accurate weather sensors that can work alongside highly accurate roadside technology will fully autonomous cars become a reality.

The Cities of the Future

What will the cities of the future look like should connected and autonomous cars become a reality? A glimpse of what is possible is set to be provided in the British city of Exeter. In December 2015, Vaisala joined forces with Exeter City Council and Devon County Council as part of a consortium led by NTT DATA to help implement a ground-breaking, two-year intelligent transport initiative. Drawing on real-time traffic and weather sensor data, as well as other data sources such as eyewitness and behavioral information, the Engaged Smart Transport project will identify where and why congestion occurs and help to come up with solutions to tackle the issue. It is hoped this will help Exeter's transport infrastructure cope with a growth plan that will see 12,000 new homes, 60 hectares of new business land and 40,000 square meters of new retail space added to the city by 2026.

While projects such as this represent the first step towards truly smart cities, what might the urban environments of the future look like once the full potential of the technologies of the future are unlocked? The possibilities are endless. At first, the rise of connected cars could lead to traffic congestion becoming significantly reduced as the exchange of real-time data allows for traffic flow to be better managed and for drivers to make more informed choices. This could deliver wide-reaching benefits ranging from reduced pollution and energy use to providing people with more free time and generally making them happier. Should autonomous cars become the norm, the extent of these benefits may be even greater. With the growing popularity of services such as Uber, it has been suggested that car ownership may be greatly reduced in the future, with people instead embracing 'mobility as a service' and sharing self-driving vehicles to fulfill their transport needs. This would reduce the number of cars on the road further, delivering environmental and health benefits, freeing up space that is no longer needed for parking and, ultimately, making cities happier, better places to live.

According to the United Nations, the world's urban population will have almost doubled to around six billion by 2050. The development of connected and autonomous vehicles and intelligent traffic will play a vital role in ensuring the cities of the future are able to manage this growth and represent a better environment in which to live than those of the past. Vaisala will continue to lead the way in developing the weather sensor technology needed to help make this happen.



Free Access to Wind and Solar Resource Data

As insecurity over our traditional energy economy deepens, the global level of support for a new energy paradigm continues to rise. Sustaining the momentum of this worldwide shift requires more than a vision for the future - it requires constantly pushing ideological, technological, and informational boundaries. A great stride has recently been made in the latter of these, when environmental measurement and consultancy firm Vaisala teamed up with the intergovernmental group known as IRENA (International Renewable Energy Agency) to provide free public access to global wind and solar data. These records, which include average annual solar irradiation and average annual wind speed, will effectively reduce a major, longstanding barrier of entry into renewable energy markets: a lack of accessible and reliable resource data.

How, and Who, Will This Help?

Vaisala's extensive datasets will now be available to download using IRENA's Global Atlas program, a free online tool which makes it possible for users to integrate data directly into their own modeling or research software. For the first time, developers, policy makers, investors, and researchers will be able to make decisions about renewable energy projects that incorporate a large amount of consistent, high-quality data from all over the world.

It will assist developers by improving their knowledge of how renewable energy infrastructure should be designed, and where it should be placed, in order to maximize yield. Legislators, meanwhile, will be benefitted by the additional insight that the data provides into how regional governments can support the expansion of renewables through policy setting. Perhaps the significance of this data becoming publicly accessible is most obvious, however, in terms of the advantage it offers researchers, who now have a vast collection of records, statistics, and samples with which to compare results, modify projections, and enhance their analyses of ongoing studies.

The effect that the data will have on investments within the renewable energy sector will be less direct, but just as important. In the words of **Nicolas Fichaux**, IRENA's Senior Programme Officer, it should serve to "...increase the confidence of governments, investors, and the supply chain in new and emerging renewable energy markets," by providing a trustworthy source of detailed global maps showing exactly where the resources are.

Vaisala's Global Manager of Energy Services, **Pascal Storck**, expressed similar optimism for outcomes related to the company's partnership with IRENA, saying that making resource data publicly available is "an essential first step when it comes to supporting global renewable energy expansion." By making the data free to access, Vaisala is demonstrating a strong commitment to the international community surrounding renewable energy sources, with Storck describing it as symbolic of the company's "responsibility to minimize investment risk for the industry."

Long Term Benefits

For now, the benefits of this cooperation will mostly be experienced by professionals and organizations within the renewable energy industry. In the big picture, however, it represents a potential leap forward for all consumers. Making data open and accessible paves the way for it to become meaningful on a much larger scale, providing innovators a foundation for future applications, which Vaisala is well positioned to support through observations, services, and consulting. While resource data by itself will not unlock an endless supply of energy, it does enable us to envision and ultimately create such a future together.

Increased Efficiency with Network Manager

by Olli Ojanperä, Product Manager, Vaisala, Finland

Automated and centralized remote monitoring and control of weather observation networks increases operational efficiency, improves safety and reduces lifetime costs.

Weather observations are the starting point for weather forecasting, services and operations. Thus, taking good care of the observation network is vital. It ensures the continuous high-quality performance of the provided weather services and weather critical operations.

The initial investment in weather observation systems and sensors can seem high, but the lifetime cost of managing and maintaining all of these assets can far exceed the initial investment. So finding the right solution that can be adapted and scaled in step with changes in the operating environment is essential.

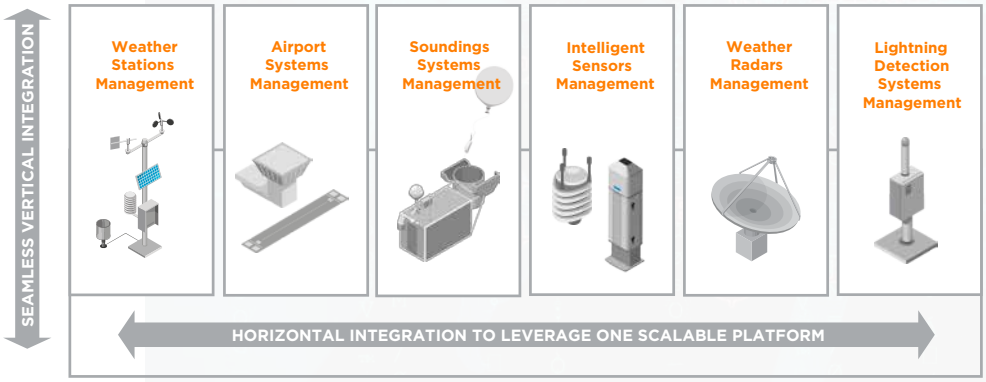
Having access to all weather observation data from all sites in one place is the new industry standard. Today, economical and more reliable hardware and communications through secure Internet Protocol networks are enabling fundamental changes in how agencies and countries manage their individual weather observation sites. Integrating weather observation sites using the communication protocols right for the agency's needs make it possible to monitor and control everything from one centralized office.

Implementing a scalable, flexible and open management solution with support for various different autonomous observation systems and intelligent field devices will enable optimization of observation network operations, improved safety and easier operation in remote locations.

Continuous, Reliable Observations

Vaisala Observation Network Manager NM10 connects individual systems, sensors and devices, allowing customers to monitor and control their weather observation sites from one location. Using one platform, users can collect high-quality data from multiple observation sites. As the system is accessed through a web browser, 24/7 monitoring is possible from any device or location.

High-quality observations are crucial when the data is used in



NM10 enables horizontal integration of variety of different observation systems and devices with efficient capabilities to centrally operate, maintain and diagnose the network via browser-based tools.

decision-making in critical operations and public safety. Active monitoring of the weather observation sites provided with automatic real-time data quality control capabilities ensures and increases the volumes of reliable observations and high quality data. It also improves significantly the ability to react immediately when issues need to be solved.

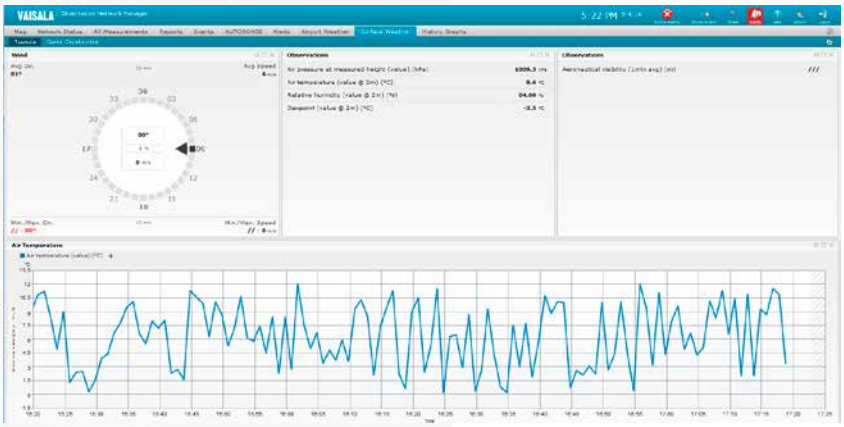
Optimized Lifetime Support

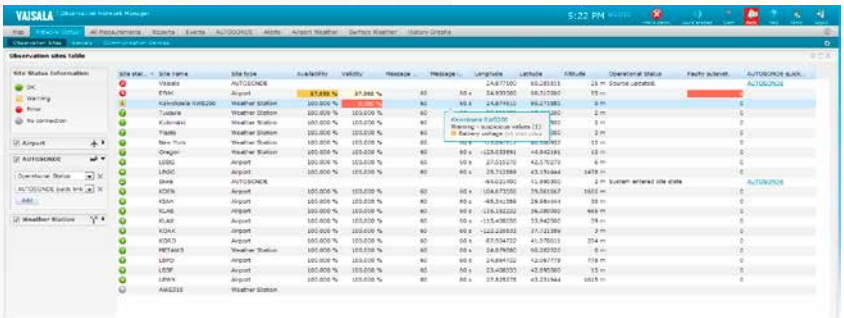
Perfect for both small and large networks, the NM10 is fully scalable to make extending the system quick and easy with an affordable price tag. Extensive support together with proven performance and functionality significantly reduce the implementation time and total lifetime costs, helping to stretch the budget further. With real-time, continuous monitoring of the entire network, customers can make informed decisions based on the best possible data. Alongside network monitoring, the NM10 provides alerts and notifications as well as remote diagnostics and control services which help in reducing maintenance and operational costs.

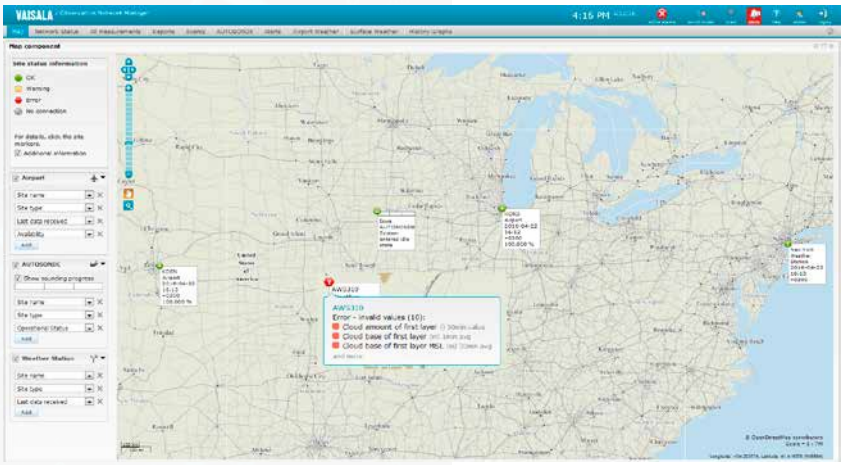
Continuous support services, modernization and efficient upgrades provided by a global market leader and trusted partner for years to come will help the end users to utilize the most advanced technologies available to improve their performance both now and in the future.

Shorter Site Visits and Correct Actions

With remote access and continuous monitoring, the NM10 can help cut the number of maintenance visits to remote sites. Having received information about the fault in advance, decision-makers can make sure the issue at hand will be addressed efficiently: the most competent staff will be alerted to the site and they will be equipped with the correct tools and spares to remedy the issue.







Moreover, by having the possibility, for example, to remotely give permission to launch a radiosonde balloon from Vaisala AUTOSONDE® system can significantly increase the efficiency of daily routine tasks as well as convenience in operations.

To achieve improved oversight of network performance and weather conditions detailed views of surface weather observations, data quality and network status are provided on wind rose, chart, text, GIS map, list and report widgets on the fully configurable web user interface.

What Does Total Lightning Mean Anyway?

You have probably heard the term "total lightning," but do you know what it really means? In short, it means the detection of both cloud lightning and cloud-to-ground lightning, giving us a more complete view of the activity in a storm. The study of cloud lightning is bringing scientists new research data, and is allowing meteorologists to understand better the relationship between lightning and severe weather.

Cloud-to-ground lightning has been extensively studied for decades, and private companies like Vaisala are continuing to perfect the accuracy of location and timing of these strikes. After all, cloud-to-ground lightning directly affects the places where we live and work – from disrupting electric power systems to impacting recreation and travel. Accurately detecting cloud-to-ground lightning allows us to be prepared, stay safe, and operate weather critical business efficiently during adverse weather.

Through the study of lightning, lessons have been learned that there is an association between cloud lightning and severe weather, including the threat of high winds, hail and wind-shear. Also, as forecasting techniques evolve, there is increasing value in detecting both cloud and cloud-to-ground lightning with higher quality. However, differentiating between these two types of lightning is extremely important in certain critical operations. For example, reliable identification of cloud-to-ground lightning is essential in electric-power transmission management.

In addition to differentiation, uniform detection capability is key to assessing storm development and the potential for severe weather, where the rate of total lightning and the ratio of cloud lightning to cloud-to-ground lightning are thought to be key factors.

Detecting Cloud and Cloud-to-Ground Lightning

Lightning detection systems detect electro-magnetic pulses emitted by lightning discharges. Vaisala's LS7000 series sensors are engineered to detect the Very Low Frequency (VLF) and Low Frequency (LF) signals emitted by cloud-to-ground lightning strikes and cloud pulses. Vaisala's LS7000 series sensors are engineered to detect the Very Low Frequency (VLF) and Low Frequency (LF) signals emitted by cloud-to-ground lightning strikes and cloud pulses.

This frequency range is optimal for detecting and classifying these lightning discharges over long distances, which allows Vaisala to design networks that have 70% fewer sensors than required with any other technology and, at the same time, provide industry leading performance and uniform coverage over wide areas.

Vaisala's approach to detecting lightning is to develop technology that delivers only data that is assessed, with a high degree of certainty, as being either cloud-to-ground or cloud lightning, and Vaisala is the first company to resolve the problem of properly classifying cloud lightning and cloud-to-ground lightning. Using technology developed for the Vaisala Thunderstorm Advanced Total Lightning Sensor LS7002, Vaisala is able to bring accurate total lightning to its users with improved sensitivity to detect weaker cloud pulses. This technology furthers the capability to discriminate correctly between cloud-to-ground and cloud lightning, while significantly increasing the amount of cloud lightning reported.

Correct Classification of Lightning is Important

Where lightning data plays a role in your decision making process it is important to make sure you are getting accurate information, not just "dots on a map". High data quality ensures you have a trustworthy source of information for weather models, forecasting, advance warnings, safety, operational efficiency and asset monitoring.

There are three important performance considerations when selecting a lightning network. The first is to detect as much lightning as possible within the network and in the immediate vicinity. This capability is known as high detection efficiency. A cloud-to-ground or cloud flash is said to be "detected" if one or more of the pulses in the flash are detected and reported by the lightning network.

The second is to determine the positions of individual lightning discharges as accurately as possible, or in other words, ensure location accuracy is at the highest level. The location accuracy of a network is particularly important for cloud-to-ground strikes. Vaisala uses Combined Technology - magnetic direction finding and advanced time-of-arrival - to provide accurate locations of both cloud-to-ground and cloud lightning. This patented approach to lightning detection provides the major benefit of delivering accurate lightning locations, while maintaining a high detection efficiency, with far fewer sensors than any other method. The third is proper classification of lightning – was it cloud lightning, or cloud-to-ground lightning? It is well known that most of the lightning occurring in a storm is cloud lightning, and while detecting both types is readily accomplished, it is much more challenging to provide a clean dataset with a high degree of classification accuracy. Any lightning network can claim to provide total lightning, but what are you really getting? Total lightning counts alone do not provide the best or most complete information. Proper classification requires using sensor technology that intelligently detects and filters the signals, together with advanced algorithms that properly differentiate cloud lightning and cloud-to-ground lightning.

In lightning detection, as in all aspects of weather observation, it is of utmost importance to Vaisala that customers are always getting the most accurate weather information in a timely and cost effective manner, weather information that can be relied on.

Superior Wireless Monitoring for Indoor Environments

Vaisala has launched a new environmental monitoring system with wireless signal that travels over 100 meters indoors. The totally redesigned viewLinc monitoring system now offers long-range wireless communication, ease of use, and fast deployment.

"The previous version of the viewLinc system has long been used by pharmaceuticals, but it is also ideal for monitoring other high-value assets that are affected by environmental conditions, such as air temperature or humidity. It is used in museums, galleries, and in IT server rooms," says Vaisala Product Manager **Jon Aldous**.

viewLinc provides trends, alarming, and customizable reporting that ensures accurate environmental information via a wide selection of Vaisala devices that monitor temperature, humidity, CO_2, and other variables.

Read more:
www.vaisala.com/viewlinc

Measuring Carbon Dioxide in Agriculture

Vaisala introduces a new carbon dioxide probe for agriculture, greenhouses, refrigeration and demanding HVAC applications.

Agriculture either uses or produces carbon dioxide in many places: CO_2 is used as a fertilizer e.g. in greenhouses or needs to be controlled and ventilated at mushroom farms. Stable and accurate performance is essential in these types of wash-down and humid environments.

The Vaisala CARBOCAP® Carbon Dioxide Probe GMP252 measures from 0 to 10 000 ppmCO_2, and with slightly reduced accuracy even up to 30 000 ppmCO_2. The operating temperature ranges from -40 to +60 °C, and the probe has IP65 classified housing.

Helping Plants to Grow

"Greenhouses often have high humidity levels and lots of chemicals present. Carbon dioxide fertilization helps plants to grow, accelerating photosynthesis. Vaisala measurement devices are very accurate, need minimal maintenance, and have minimal long-term drift. Stability is an important feature, since a drifting measurement might result in over-using carbon dioxide. That is expensive for the farmer and can even be harmful for the plants," says **Maria Uusimaa**, Product Manager at Vaisala.

The GMP252 uses Vaisala's proprietary CARBOCAP® technology and has a microglow light source. "The microglow chip is a silicon MEMS emitter infrared source, which improves the reliability and stability of the probes. Using this light source instead of traditional filament lamp brings better accuracy and stability of the CO_2 measurement and prolonged lifetime of the product," says Uusimaa.

Yokoso, Vaisala e! – Welcome to the New Tokyo Office!

After almost 30 years, the Kagurazaka office had grown too small and outdated for Vaisala's expanding business in Japan. Finding new facilities was complicated by the buzz generated, even on the property market, by the approaching Tokyo 2020 Olympics.

The new office had to be on one floor, suitable for the salespeople as well as the Calibration and Repair Services (CRS) laboratory and its equipment, and have good logistics and connections.

A suitable space was found in Jimbocho, famed for its book stores. At 700 square meters, the new office easily houses today's 40 employees and should provide enough room for Vaisala's Japanese operations for the next decades.

"In addition to having up-to-date facilities for our CRS operations, we wanted to invest in comfortable and inviting spaces for customer meetings. The design is fairly Scandinavian, but especially in the open-plan office, we have kept the design Japanese," says **Jan Grönblad**, President of Vaisala KK.

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