

MEMS Project in Saudi Arabia: Global Solution Business Initiative

● Naoki Shiraishi ● Norio Yabe

The MODON Environment Management System (MEMS) project started with a feasibility study on eco-industrial cities as part of the "Fiscal Year 2011 Project Commissioned to Research and Promote Infrastructure-related System Export (Business Feasibility Study on Smart Communities in the Global Market)" sponsored by the Japanese Ministry of Economy, Trade and Industry (METI). This led to Fujitsu being awarded a contract to construct ambient air, emission air, and ambient, industrial water, and wastewater systems in three major industrial cities covered by MODON, which means "cities" in Arabic. This construction was carried out in collaboration with Fuji Electric Co., Ltd., METAWATER Co., Ltd., Eco Analysis Corporation, Mizuho Bank, Ltd., and experts in many different fields from academia and Kawasaki City. This paper describes how Fujitsu obtained the contract and carried out the project and gives an overview of the system, current project status, and future vision.

1. Introduction

The Saudi Industrial Property Authority, or MODON (meaning "cities" in Arabic), oversees about 20 industrial cities in Saudi Arabia as a government agency under the Ministry of Commerce and Industry. In addition to developing and operating these industrial cities, MODON plays an important role in the country's economy by promoting industry, eliminating regional disparities, and creating employment opportunities for young Saudis, which has recently become a pressing issue.

Dr. Tawfig Alrabiah, the former Director General of MODON, announced in August 2011 that MODON was planning to construct more industrial cities to bring the total number to about 40 by 2015, thereby doubling the number at that time and creating 800 new enterprises. A great variety of companies are moving into these industrial cities, representing diverse manufacturing fields including building materials, chemical products, petrochemical products, foodstuffs, metalworking, machinery, furniture, paper manufacturing, and fibers. The existing industrial cities are home to 4000 domestic or foreign factories employing more than 300 000 people. MODON has been expanding

the scale of business yearly and is making plans for aggressive business development in support of economic growth.¹⁾ Furthermore, being acutely aware that business expansion can intensify environmental pollution within these industrial cities, MODON has been pursuing original environmental measures in accordance with environmental standards set forth by the Presidency of Meteorology and Environment in Saudi Arabia.

This paper describes Fujitsu's participation in the MODON Environment Management System (MEMS) project, from being awarded a contract to construct and operate ambient air, emission air, and water/wastewater systems in three major industrial cities covered by MODON to making plans for future expansion.

2. Background

In 2010, a connection was established with the Director General of MODON through the recently appointed Saudi Ambassador to Japan, and, on the basis of this connection, Fujitsu approached MODON with various proposals over an 18-month period under the auspices of projects sponsored by the Japanese Ministry of Economy, Trade and Industry (METI).²⁾

Then, in 2011, Fujitsu set out to obtain a better understanding of environmental monitoring and improvement in industrial cities so that it could make more specific proposals given the interest shown by MODON in the environment. To this end, Fujitsu formed a consortium with Fuji Electric Co., Ltd., METAWATER Co., Ltd., and Eco Analysis Corporation—experts in emission air and electric power, industrial water/wastewater, and ambient air, respectively—and began discussions on environmental improvement in Saudi Arabia together with Fujitsu Arabia, a subsidiary of Fujitsu Limited.

Next, in 2012, Fujitsu conducted feasibility studies in Dammam 2nd Industrial City, which had been targeted by an environmental improvement directive issued by the then Prince of the Eastern Province of Saudi Arabia. These studies focused on sites and factories selected in consultation with MODON in relation to substances targeted for measurement and techniques essential to determining current environmental conditions in various areas such as air and water. First, for ambient air, these studies showed that targeted substances could be detected at somewhat high levels at

sites near roads and in sites and factories equipped with specific types of facilities. Next, for emission air, they found that quality was dependent on factory process management, and finally, for water, they suggested that process management at sewage plants was not as thorough as desired.

In February 2012, MODON and Fujitsu Arabia signed a second memorandum of understanding (MOU) under the umbrella of the Saudi Arabian and Japanese governments.³⁾ Then, in April of that year, professors and other experts from academia, Kawasaki City, and Mizuho Corporate Bank, Ltd. joined the consortium to provide helpful information on all aspects of the environment and to give advice on the direction of system design. Finally, in November of that year, an environmental symposium was held in Dammam City on the east coast of Saudi Arabia, and, as a result of the many proposals Fujitsu had made, it was awarded a contract under the MEMS project to construct and operate various systems in three major industrial cities (Figure 1).⁴⁾

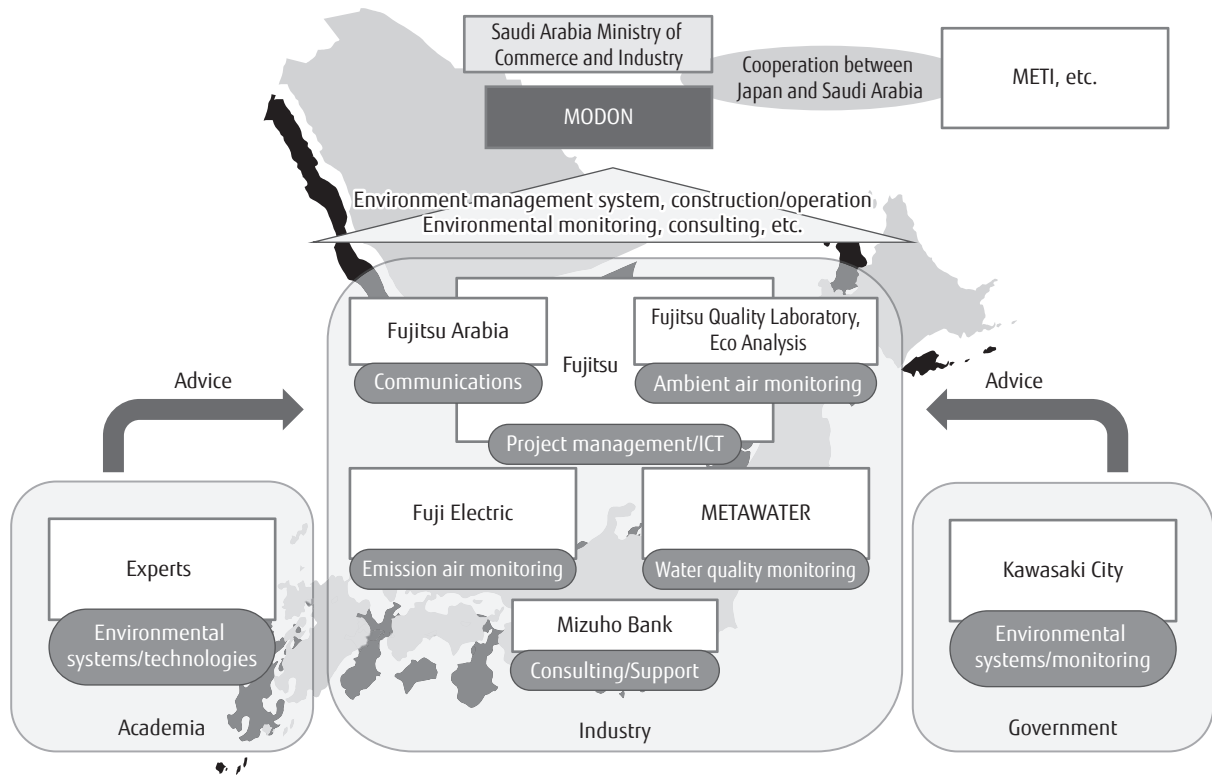


Figure 1 MEMS Implementation.

3. Know-how at time of project execution

When we, the authors, joined the project, we recognized the importance of gaining experience and know-how before being awarded a contract. Nevertheless, we were able to accumulate the following experiences and know-how through direct contact with people and institutions in the country and apply them to project execution.

1) Learning about cultural differences

To learn about the cultural differences, a key to being successful in business overseas, we focused on learning about the characteristics of Saudi Arabians in conjunction with the national policy of "Saudization" as well as the characteristics of the foreign workers (Filipinos, Indians, Bangladeshis, and others). Special consideration was given to certain periods such as Ramadan (fasting) and Hajj (pilgrimage), the holidays associated with those periods, work practices before and after those holidays, and outdoor work during the summertime from June to August (when temperatures can exceed 45°C).

2) Developing trusting relationships

Executing a project as part of a consortium differs from Fujitsu's usual approach to constructing a system. In a consortium, developing trusting, person-to-person relationships is essential, making it essential to understand differences in national and corporate cultures and in the personalities of stakeholders.

Two things in particular reflected this need. First, we found that understanding the present state of housing in Dammam 2nd Industrial City and learning about the personalities and human qualities of those in charge helped us to develop trusting relationships, as did understanding the differences between Fujitsu and other companies and providing mutual support.

Second, after a number of long-term stays in Saudi Arabia starting before the execution phase, we found that trusting relationships could be formed by first understanding the human qualities of all stakeholders, from both MODON and Fujitsu Arabia. It was also important to understand their approach to work and their public and private ways of thinking and to share each other's culture. We also came to appreciate how a close personal relationship promotes business creation in Saudi Arabia.

3) Learning about differences and similarities in

project execution

We learned that the approach to project execution is affected by national and personal cultural differences. For example, we placed importance on a visually appealing design and proposed a somewhat futuristic graphical user interface (GUI), hinting at the unique and extravagant appearance of many buildings in the Middle East such as the Burj Khalifa skyscraper in Dubai. Although this approach differed from the traditionally conservative approach in Saudi Arabia, it received high praise from our customer.

A similarity we discovered is between execution in a "don't rush, don't panic, don't give up, and don't be gullible" spirit, which is based on a famous slogan in Middle East business, and Fujitsu's slogan, "quality built-in, with cost and performance as prime consideration." It is this type of thinking that probably played a role in our being awarded the contract.

4. MEMS and service overview

The MEMS project targets Riyadh 2nd Industrial City, Dammam 2nd Industrial City, and Jeddah 1st Industrial City. A fixed station in each of these cities makes continuous measurements of the characteristics of the ambient air, and a mobile station make non-continuous measurements of the characteristics of the emission air and industrial water/wastewater. An ArcGIS server group at MODON headquarters is used to collect and manage the data obtained by these measurements via the network, and the packaged software described below is used to perform integrated environmental monitoring (**Figure 2**).

4.1 Measurement targets, methods, techniques

The measurement targets are ambient air, emission air, and industrial water/wastewater.

1) Ambient air

The fixed station in each city uses four sensors to measure nitrogen oxide, sulfur dioxide, and hydrogen sulfide concentrations and various types of meteorological data (such as wind direction and wind speed) and uses a network camera to capture still images of the peripheral area. These data are collected at regular intervals and transmitted in real time to servers at MODON headquarters for processing and storage.

2) Emission air

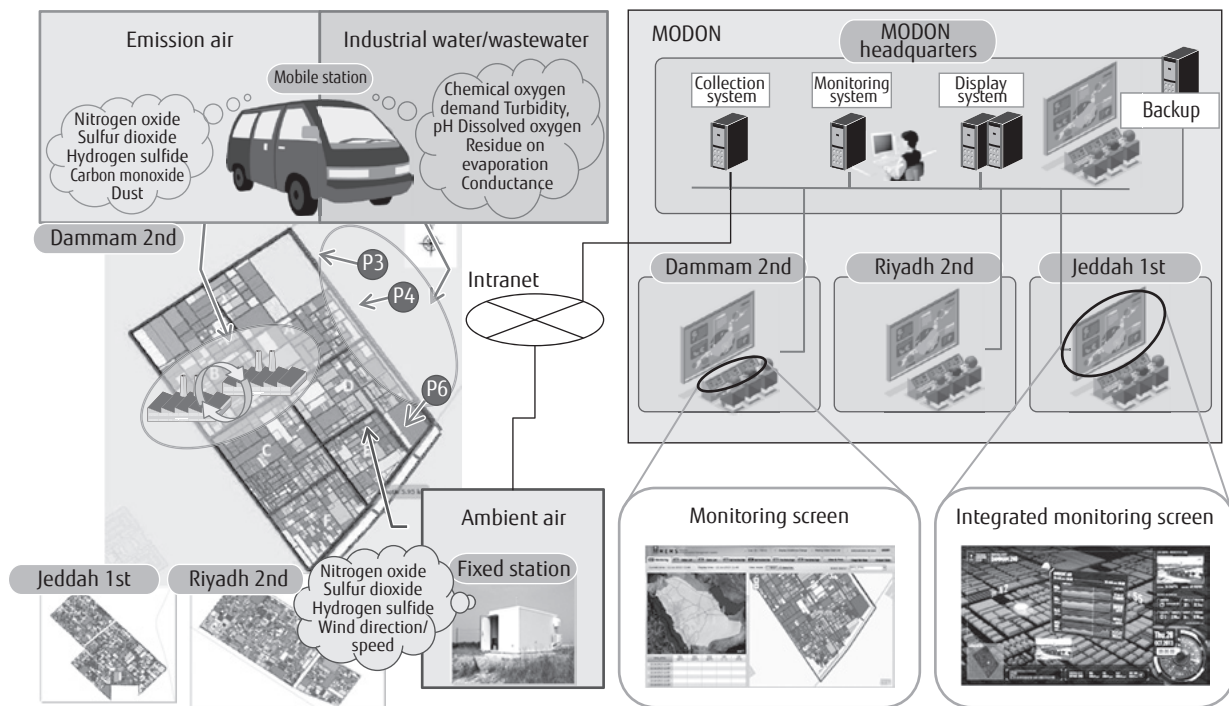


Figure 2
MEMS system overview.

The mobile station (a large van) in each city uses three handheld sensors to make measurements of atmospheric emissions. The mobile station operator uses these sensors to make manual measurements in ambient air at multiple factories at points where emissions originate (smokestacks, vents, etc.). In addition to nitrogen oxide, sulfur dioxide, and hydrogen sulfide, these measurements also target carbon monoxide and dust. Measurement results are uploaded on demand to servers at MODON headquarters.

3) Industrial water/wastewater

The mobile station operator also takes water samples at targeted industrial purification and sewage plants and factory drainage facilities. Using two sensors provided at research facilities in each city, the manager measures various characteristics including chemical oxygen demand, turbidity, pH, dissolved oxygen, residue on evaporation, and conductance. Collected data are manually uploaded to MODON headquarters.

4.2 GREENAGES software package

A software package called GREENAGES was introduced for integrated monitoring of environmental data. It enables ambient air, emission air, and industrial

water/wastewater to be monitored in real time, displays network camera images (still/video) of conditions within a city, and represents measurement data by 3D graphics (**Figure 3**).

1) Monitoring function

This function enables a mobile station operator to continuously monitor measurement data on ambient air, emission air, and industrial water/wastewater by using a Web browser. Specifically, it can display data on ambient air in real time and data on emission air and industrial water/wastewater on demand. It features a variety of modes including one for displaying updated measurement data on a map of the city and one for displaying measurement data in table format sorted by measurement time. With this function, an operator can switch between display modes as needed (**Figure 4, top**).

2) Integrated monitoring function

This function can be used with a large-screen display system to enable conditions within a city to be instantaneously and visually understood by displaying network camera images and the results of measurements in the form of 3D graphs and 3D maps of the city. It can be used in diverse ways: in addition to

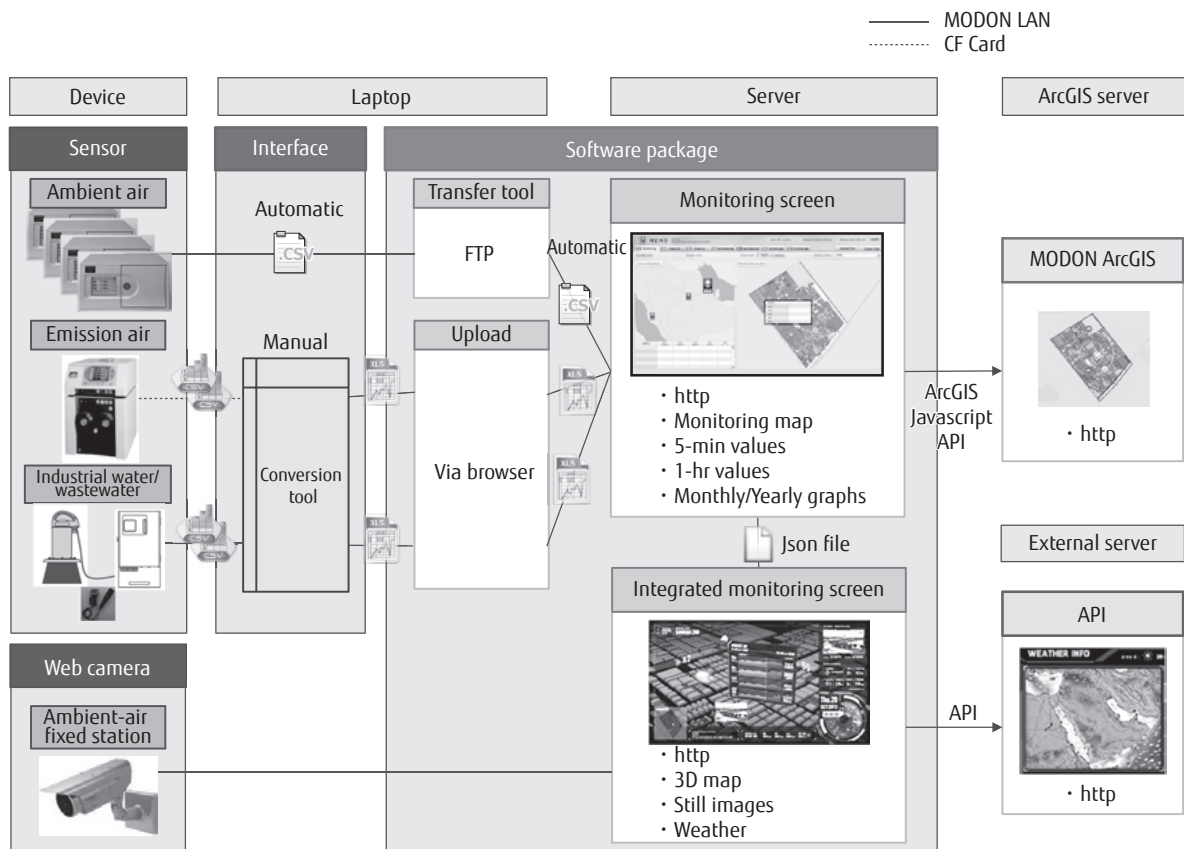


Figure 3 GREENAGES overview.



Figure 4 GREENAGES screenshots.

monitoring use by mobile station operators and personnel in integrated monitoring centers (command centers), it can also be used to display information on a screen for visitors to the city (Figure 4, bottom).

3) Report output function

GREENAGES provides a function for outputting various types of reports based on measurement data accumulated on servers at MODON headquarters. Using this function, a mobile station operator can create and print reports (monthly/yearly summaries, factory rankings in terms of pollution, etc.) in accordance with the objectives of operation plans.

4.3 System configuration

An intranet will connect MODON headquarters with each of the industrial cities in which sensors are installed. MODON headquarters will use five servers (FUJITSU Server PRIMERGY RX300 S7), each for a different application, as well as a workstation (FUJITSU Workstation CELSIUS W520) and a 60-inch display for

the GREENAGES integrated monitoring function. Each of the three cities will likewise be provided with a workstation (FUJITSU Workstation CELSIUS W520) and a 60-inch display for use with GREENAGES.

4.4 Service configuration

After implementing this system, we will provide various services from December 2013 to November 2014. MODON has high expectations in particular for the first one.

1) Consultation

As part of a consultation service, we will draw up a roadmap for the introduction of environmental regulations based on Japanese expertise and regulations and on the results of the data analysis described below. We will also propose technological improvements and cash-flow analysis as needed.

2) Monitoring

We will support daily monitoring of emission air and industrial water/wastewater in the three cities and enter the measurement data into the MEMS.

3) Data analysis

We will conduct data analysis and studies using the data stored in the MEMS.

4) Capacity building

We will provide MODON managers with opportunities to visit environmental facilities in Japan and hold on-site workshops and symposiums in Saudi Arabia featuring environmental experts from Japan with the aim of sharing Japanese expertise and know-how with MODON.

5) Maintenance

We will perform regular maintenance of sensors, IT infrastructure equipment, and packaged software and large-scale maintenance once a year.

5. State of MEMS construction and future development

In this section, we describe the progress made in MEMS construction from the time of project launch (March 2013) through November 2013. Key personnel on the Fujitsu side stayed in Saudi Arabia from August to November 2013 to oversee system construction at the target sites.

5.1 Approval of project plan

A kickoff meeting attended by those in charge

of the project was held in April 2013 at MODON headquarters. At this meeting, Fujitsu submitted a project initiation document describing the project plan (scope, milestones, work allocation/system, meeting/committee structure, etc.) and received approval for the plan from MODON.

5.2 Approval of design process

Next, in May 2013, a meeting was held at MODON headquarters to assess the entire MEMS design. Fujitsu submitted a specifications definition completion report describing all environment measurement equipment (sensors) and IT infrastructure equipment (servers, etc.) to be deployed by Fujitsu and associated software specifications and received approval for the design from MODON. With approval obtained, it was decided to commence manufacture and development of all equipment and software.

5.3 Sensor installation

Sensor manufacturing and shipping (export) were conducted during the Islamic Ramadan period. The fixed stations for each city were installed under severe temperature conditions ($> 45^{\circ}\text{C}$), and those in charge at Fujitsu held on-site meetings daily to see how this work was progressing. Preparations for operating the fixed stations in the three cities were completed in November 2013.

5.4 Deployment of IT infrastructure

As in the case of sensors, IT infrastructure equipment was shipped from Fujitsu Technology Solutions in Germany during Ramadan, and final adjustments to the system construction procedure were agreed upon by those in charge at Fujitsu Arabia and Fujitsu. MEMS operation between MODON headquarters and the three cities commenced in November 2013.

5.5 GREENAGES development

The GREENAGES development team in Japan performed software integration testing using the package test environment and prepared system documentation. Once software quality and performance were ensured, development team members went to Saudi Arabia to perform final system testing using actual MODON equipment (sensors, IT infrastructure equipment) in the three industrial cities, one by one, from September

to November 2013.

5.6 Future expansion

At Fujitsu, we look to construct and operate the system by applying the spirit and know-how described above at the time of project execution. We also would like to consult on the construction of eco cities and smart communities in Saudi Arabia by accumulating more know-how and data from the MEMS operation phase and applying Japanese know-how on overcoming environmental pollution problems (Figure 5).

6. Conclusion

This paper described how Fujitsu was awarded a contract under the MEMS project to construct and operate ambient air, emission air, and industrial wastewater systems in three industrial cities in Saudi Arabia. It outlined the systems and services and described the state of system construction as of November 2013. Using this system as a stepping stone, Fujitsu seeks to leverage its information and communications technology (ICT) and environmental solutions know-how and the valuable solutions provided by the consortium members to make a major contribution to the development of eco-industrial cities in Saudi Arabia by providing an integrated infrastructure and service package.

In closing, we would like to extend our deep appreciation to the Information Economy Division of the Commerce and Information Policy Bureau at METI, Motoyuki Suzuki, Professor Emeritus, the University of Tokyo, Professor Koichi Fujie, Yokohama National University, Professor Kensuke Fukushi, the University of

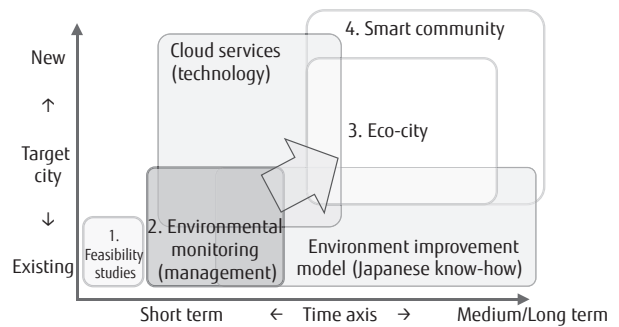


Figure 5 Transition to a smart community.

Tokyo, and Kawasaki City for their invaluable assistance in the execution of this project.

References

- 1) Japanese Ministry of Economy, Trade and Industry (METI), Fiscal Year 2011 Project Commissioned to Research and Promote Infrastructure-related System Export (Business Feasibility Study on Smart Communities in the Global Market), Saudi Arabia Smart Industrial Cities, Market Analysis (in Japanese). http://www.meti.go.jp/meti_lib/report/2012fy/E002959.pdf
- 2) Environmental Improvement of Industrial Cities—Fujitsu DNA Wins the Heart of Saudi Arabia. *Wedge*, June 2013, pp. 28–31 (in Japanese).
- 3) Fujitsu: Press Release (February 2, 2012). <http://www.fujitsu.com/global/news/pr/archives/month/2012/20120202-02.html>
- 4) Fujitsu: Press Release (March 11, 2013). <http://www.fujitsu.com/global/news/pr/archives/month/2013/20130311-01.html>



Naoki Shiraishi
Fujitsu Ltd.
Mr. Shiraishi is engaged in the MEMS project.



Norio Yabe
Fujitsu Ltd.
Mr. Yabe is engaged in the MEMS project.