

# technology review **INDIA**

MIT's Magazine on Innovation

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## THE GRAND **CHALLENGES** FOR **TECHNOLOGISTS** IN INDIA

Agro App, Future School, Communication Aid, Smart Power, Mobile Health Care, Automated Traffic Management, and Water Purifier. **p33**

Searching for the Future of Television **p54**  
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## Innovative Solutions Made for India

Technologists respond admirably to *Technology Review* India's Grand Challenges Project.

The six month wait to know the results of the first *Technology Review* Grand Challenges project for technologists, assisted by DuPont as the Strategic Partner, is over. A 12 member jury of technologists, researchers, technology promoters, helped by the magazine's editorial team, has chosen the best solutions from over 200 entries received in the last few months. Though most of the solutions were good, in four of the 10 segments they did not make the cut.

In agriculture, methods to reduce the phenomenal wastage of produce at the ground level was the challenge. mKrishi, a software-based advisory platform which combines ground based sensors and mobile signals, has won the jury's vote as the best solution possible currently. Developed by Bhushan G. Jagyasi and Arun Pande of Tata Consultancy Services, the platform has the ability to provide warnings to farmers about impending pest attacks, take preventive measures, using the ubiquitous mobile phones.

Providing cost-effective education in India's vast hinterland has been a major challenge. The jury found the personalized education delivery system based on cloud computing platform, developed by Hewlett-Packard Laboratories India, the most innovative technology solution to develop future schools in India. The HP team of Sudhir Dixit, Krishnan Ramanathan, Ashish Sharma, and Srinivasa Ramani has developed an online school hosting service too to help spread the benefits of education to millions of school children around the country.

Meeting the ever-growing need for energy in India's fast growing economy has been a major cause of concern for policy makers. The solution developed by Kumar Padmanabh and Sanjoy Paul from Infosys Technologies is a smart chip that can be plugged to all power-hungry devices. The chip can identify energy wastage and can be controlled remotely using mobile phones.

India's mobile revolution has really spurred technologists to develop applications in many segments. The best solution in the health care category is SiteOnMobile application developed by Geeta Manjunath, Revathi MM, and Sudhir Dixit at HP Labs India. The application delivers a variety of health care related information to health care providers in all corners of the country using even low-featured mobile phones both through text and voice modes. This will enable the fruits of modern medical research to reach all parts of the country.

Most Indian cities are burdened with ever increasing traffic. Malavika Sujith and Lakshminarasimham G. at Nokia Siemens Networks have developed a smart key that can be

embedded in all driving licenses. The key will communicate real-time data about the movement of the vehicle to a central server. If all driving licenses use this key, every time a vehicle hits the road it will be possible to estimate traffic density. It will also be possible to track unlicensed drivers on the road.

A low-cost water purifier, Sujal, developed by Chetan Malhotra, Dilshad Ahmad, and Shankar Kausley using a matrix of pebble, cement, and rice husk ash, at TCS is the jury's choice as the best solution to help rural India with clean, potable water at affordable cost. In the education sector, there is an innovative solution, Signntalk, an online interpretation service to help people with speech disabilities to communicate freely with the world. Here those with speech disabilities have to connect to the company's website through the Internet. A round-the-clock call center will have interpreters who read the sign language and communicate their messages to anyone they wished to speak to. Developed by Ramya Venkitesh from a small Mumbai-based company, Barrier-Break Technologies, Signntalk has the potential to transform the lives of millions of people in the world. The editors of TRI used their discretion to make Signntalk an Editors' Choice solution.

TRI is indebted to each of the 12 jury members for their immense efforts, sincerity, and commitment to evaluate nearly a dozen solutions, each minutely, over the last few weeks. In fact, all the jury members went out of their way to evaluate the solutions keeping up their promised commitment to us despite facing unforeseen challenges like some being stuck in the inclement weather conditions in European airports.

According to a jury member, Sumitesh Das, Tata Steel, some of the entries were still in the development phase (at best classified under inventions to be). However, innovation is about making money out of an invention and putting different strings together. "I really enjoyed going through the submissions," he said.

TRI Editor, Chandan Srinivas Rao, who handled this project admirably summed it up nicely, "Our understanding when we started the project was that the technologists of the country need to come together to architect solutions to solve complex problems in simple ways. This has certainly happened in a small way through this concerted effort. As a technology community, we still have a long distance to cross to reach the destination. But it is bound to happen sooner than later."

On that note I wish you all a great year ahead in 2011. Do write and let me know about our efforts to promote India-made technology solutions at sureshn@cybermedia.co.in.

– Narayanan Suresh

# THE GRAND CHALLENGES FOR TECHNOLOGISTS IN INDIA

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DuPont brings game-changing science and engineering to the global marketplace in the form of innovative products, materials, and services that make a difference. It does so by working collaboratively around the world with customers, thought leaders, and visionaries, and in public/private innovation partnerships, tackling such fundamental challenges as feeding a growing global population; decreasing the world's dependence on fossil fuels; and keeping people and the environment safe from harm. DuPont believes in the transformative power of science and the problem-solving might of inclusive innovation to drive sustainable solutions. Founded in 1802, the company is headquartered in Wilmington, Delaware.



# TRI GRAND CHALLENGES TOP SOLUTIONS: AGRO APP, FUTURE SCHOOL, COMMUNICATION AID, SMART POWER, MOBILE HEALTH CARE, AUTOMATED TRAFFIC MANAGE- MENT, WATER PURIFIER

*Technology Review* India features innovative technologies and solutions relevant to solving some of the most urgent challenges facing the nation. In our anniversary issue (July 2010) we published a core list of technological challenges that India is grappling with so that technologists have enough reason, passion, and single-minded focus in solving the problems. The objective was to generate useful new ideas that could have a widespread impact on India's technological temper in general. After an extensive search for solutions over three months, in November, we shortlisted 70 solutions from over 200 that we received. Helped by a panel of expert judges, we now present you top seven winning solutions from six challenge areas which we believe can tackle problems in a way that is likely to benefit society and business. We look forward to see them implemented in near future. Hope you like the selection. — *The Editors*



## THE JURY



**Ambuj D. Sagar**  
 Vipula Mahesh Chaturvedi Professor  
 Indian Institute of Technology, Delhi



**J. Srinivasan**  
 Chairman, Divecha Centre for  
 Climate Change, Professor, Centre  
 for Atmospheric and Oceanic Sci-  
 ences, Indian Institute of Science



**Sumitesh Das**  
 Chief, Global Research Program  
 Tata Steel



**H. Harish Hande**  
 Managing Director  
 Selco-India



**Mohanjit Jolly**  
 Managing Director  
 Draper Fisher Jurvetson



**Umesh Malhotra**  
 Founder  
 Hippocampus



**Harshal J. Shah**  
 Chief Executive Officer  
 Reliance Venture Asset Management



**Mukul Saxena**  
 Senior Vice President and Head  
 Siemens Corporate Research and  
 Technologies



**Wido Menhardt**  
 Chief Executive Officer, Philips  
 Innovation Center Bangalore  
 Philips Electronics India



**I. Vijaya Kumar**  
 Chief Technology Officer  
 Wipro



**Subrahmanyam Goparaju**  
 Vice President and Head, Software  
 Engineering and Technology Labs  
 (SETLabs), Infosys Technologies



**Yalla Veera Prakash**  
 Vice President - R&D  
 Acme Telepower



AGRICULTURE

# Advisory App for Farmers

mKrishi is an advisory services platform that communicates farmer's query along with other agricultural parameters to an expert at a remote location through a sensor network and mobile phone.

Human beings have been endowed with senses which help in perception of vision, sound, touch, taste, smell, pain, direction, and so on. Traditional methods of agriculture and cultivation rely heavily on human senses for decision-making. For example, observation or feel of a dry soil leads to the decision of irrigation. Now, with the advancement in electronics sensing technologies, sensors can assist farmers in accurate diagnosis and decision-making. The sensors can help in quantification of the observations in the form of measurements and at times go beyond the capacity of human senses to observe what cannot be observed naturally. Wireless technology can enable deployment of such sensors at remote locations. The mKrishi is a mobile phone based agro-advisory services platform that provides a mechanism to communicate farmer's query along with other agricultural parameters to an expert at a remote location through a sensor network and mobile phone. It also enables the expert's advice to reach the farmer on his or her mobile phone instantly and cost-effectively.

## THE APPLICATION

The proposed Rural Participating Sensing (RuPS) architecture of mKrishi incorporates wireless sensing network (WSN), mobile phone sensors,

## Highlights

**Solution Architects:** Bhushan G. Jagyasi and Arun Pande

**Company:** Tata Consultancy Services

**Challenge Summary:** India loses nearly ₹60,000 crore worth of agricultural food items due to lack of post harvesting infrastructure such as cold chains, transportation, and storage facilities, inadequate quality control and testing infrastructure, inefficient supply chain and involvement of middlemen, and high packaging cost. How to reduce the food produce wastage by 70%? How to increase the share of processed food to 20% level?



and human participation. The WSN is a network formed with large number of sensor nodes with electronic sensing, processing, and communication capability. The sensor nodes can either communicate data to the nearest mobile phone or directly to the base station.

The sensors on the mobile phone, such as camera, global positioning system, and microphones enable farmers to participate through a mobile phone application developed by TCS. The information from all the sensors gets stored in an integrated disease analysis console which can be remotely accessed by an expert who can advise the sender of the query on further course of action.

## HOW IT WORKS

India is the third largest potato growing nation in the world. And the Late Blight is the most common disease in potato farms caused by the pathogen *Phytop-*

*thora Infestans*. About 80 percent of the potato farming in India is done in the winters, which is ideal for infestation by the *Phytophthora Infestans*.

The mKrishi WSN collects details of the weather and soil parameters such as ambient temperature, relative humidity, precipitation, soil moisture, soil temperature, wind speed, and wind direction. These parameters are communicated to the remote server through a wireless modem. The existing disease forecasting models are used to compute the disease risk due to environmental factors. For example, when the weather circumstances are conducive the probability of the pest attack increases, thereby leading to a higher risk of the disease. The application installed on farmer's mobile phone can be triggered from a remote location automatically to collect symptoms of the various diseases affecting the crop. It requires the farmer to



**SYMPTOM COLLECTION** mKrishi's rural participatory sensing mobile application to collect symptoms of the plant disease in Hindi.

answer simple questions about the disease symptoms with simple (Yes/No) inputs. The collection of these inputs also leads to the computation of diagnosis severity and effective decision-making by the expert.

The application has been designed for various Indian languages to make it more accessible. A photograph provided with each question depicts the symptom visually to be confirmed by people who cannot read. The mobile phone sensors are likely to help farmers in capturing additional information regarding the diseases present in the farm, such as images of the diseased stem, leaves and tuber; the microphone can be used to record the voice in order to capture the context in which the images were captured and the GPS can record the exact location in the field where the infection has occurred. These sensors are helpful in rigorous analysis of the disease spread.

The disease analysis console comprises a forecasting model that pro-

cesses data from the WSN to predict the risk of the disease. Its image processing based symptoms detection algorithm processes data from sensors on the mobile phone, indicating the extent and severity of the disease.

#### **BENEFITS**

The mKrishi's forecasting system is scalable to various crops diseases and for different geographies. The system helps in establishing farmers' trust in the expert's advice as it is personalized and tailor-made for their farm unlike the traditional disease forecasting advices which were meant for a region. The participation factor is likely to boost farmers' confidence in executing the advice of the expert.

#### **CHALLENGES**

The WSN needs large-scale deployment in agricultural fields that can lead to greater impact on the yield. The key challenge lies in developing

the image processing algorithms for enabling autodetection of a particular symptom from the received images. This will facilitate concluding the type and stage of the disease. Also, wind is the main cause of the spread of the Late Blight. It transfers the sporangia from the infected plant to the plants in the neighboring farms, thereby causing a potential disease threat. The challenge is to forecast the spread of the disease based on early detection and measurement of the wind's direction and speed. Besides these, there are certain economic challenges as well. To make a farmer participate in the symptoms collection process, the system requires him or her to possess a mobile phone with basic functionality like a camera and, if possible, a GPS. Another challenge is to make the sensors easily available. However, with the involvement of more farmers sharing the infrastructure, the overhead cost will become manageable. **tr**



EDUCATION

# Future of School on Cloud

A vision of a school that will have a personalized education delivery system, leveraging research in personalization, feedback mechanisms, network architecture, computing, storage, virtual school provisioning, and education service delivery.

The industrial revolution in the eighteenth century gave rise to a model of education, with the school as a factory for mass production. The model has scaling problems, quality problems, and the notion of “one size fits all”. According to the Central Board of School Education, India has a current shortage of 200,000 schools. To build 200,000 schools will require a long time and a lot of capital. Also, building a school by itself does not ensure quality education. Unless personal attention is provided to the individual student, the quality of learning is unlikely to improve. The schools have not been able to address the problem of personalized learning, though teachers have tried to do so to some extent by giving private tuition and opening tutoring institutes. Now there is pervasive deployment of new information technology resources (computer, cell phones, other handheld devices) in the educational systems to address the pressing issues of the education sector.

The Indian government has launched major initiatives to promote education through information and communications technology. The major problems in using ICT to promote education are: difficulties in scaling up, inability to provide real-time feedback to the teacher, the cost of access devices at the user-end, and more. To overcome the challenges, the government has been steadily

## Highlights

**Solution Architects:** Sudhir Dixit, Krishnan Ramanathan, Ashish Sharma and Srinivasan Ramani

**Company:** Hewlett-Packard Labs India

**Challenge Summary:** Education is at crossroads today. Though the number of institutes have gone up significantly, most of them unfortunately provide an average education. In India, only one percent of the students go for the post graduation and 0.1 percent for PhDs. Almost 20 percent of the engineering graduates are unemployed. How to make education useful and reduce the talent gap by 50%? How technology can substitute the need created by shortage of 200,000 schools? How to increase the quality of teaching so that the number of PhDs go up to 1% level?

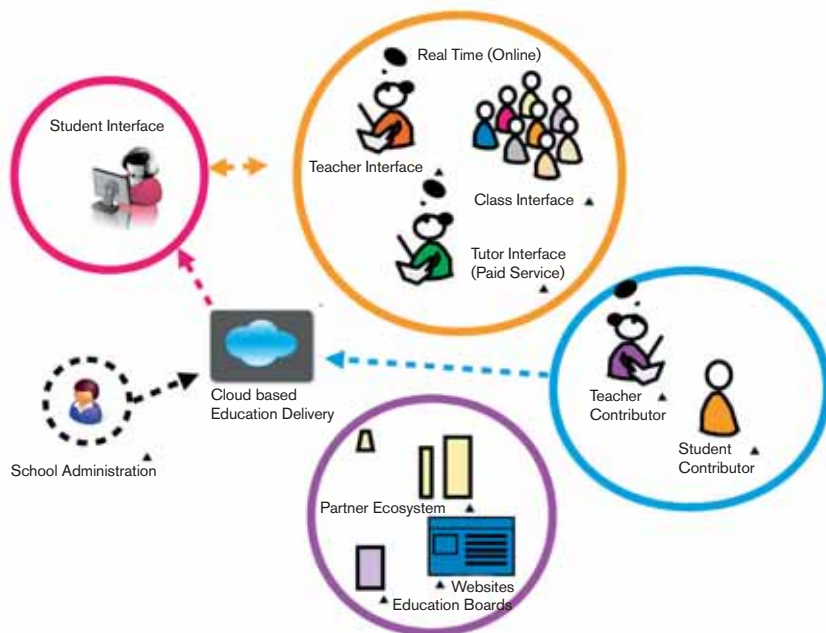


increasing the allocation of public resources to education. Moreover, with the enactment of the Right to Education Bill, there is a strong need to increase the number of teachers in schools. It is also necessary to improve the effectiveness of teachers by making available the right tools and technology. There is a need to offer students opportunities to learn by themselves for example, by watching television, using computer, studying online content. Unfortunately, these facilities are not yet available to majority of students.

### THE FUTURE SCHOOL

Hewlett-Packard has developed a new vision of how a future school will look like. It will have a personalized education delivery system dependent on cloud

platform, leveraging research in personalization, feedback mechanisms, network architecture, computing/storage, virtual school provisioning, and education service delivery. The future school will provide an online school hosting service where anyone who wishes to create an online virtual school can use the infrastructure (servers, storage, communication, and e-learning software) required for hosting and running an online school. This will also address the problem of synchronization of educational content with latest developments and industry trends. The school will facilitate teacher-student interaction for every learner to utilize services of the best teachers to get quality education from anywhere at affordable cost while encouraging a competitive envi-



**VIRTUAL SCHOOL** Hewlett-Packard's vision of how future school will look like and help in improving the standard of learning.

ronment for teachers to innovate new techniques in teaching. The interaction facility will also support institutions and teachers to offer tuition over the Internet. The future school's facilities will include audio/video sessions or online chats that would enable a convenient and effective environment for learning. In addition, there will be a facility to use educational content enrichment tools for authoring, reviewing, and publishing to promote creation of new content.

The future school will result in a large cloud platform for educational service delivery that offers personalized education with a school-like experience. On the client side, the research will focus on how to use video and personalization to automate the delivery of the routine educational content, thereby enabling teacher interaction to be focused on the content the student has trouble understanding. The future school will enable virtual classrooms, collaboration, educa-

tional networking, and service delivery aspects to provide a good learning experience. On the server side, HP's research will focus on creation of a cloud based, multi-instance hosting platform where multiple online schools can simultaneously run.

HP plans to focus on enhancing user experience through personalization with user selection of preferred media – text, video/audio, slides, and more. The student's learning style would be taken into account to choose the appropriate method of instruction. The system will provide for student-teacher interactions to occur over the network, to handle situations in which the student is unable to learn a topic without human help. The solution will support virtual classrooms in which groups of students can be given presentations.

#### THE IMPACT

The Future School project will need to be carried out in phases beginning with pilot projects and creation of the technical infrastructure in parallel with relevant research and training as well as building up of large groups of educational content and service providers. Collaboration between brick and mortar institutions and online schools would be required to provide the right blend of educational resources—human and technical, physical and virtual. This proj-

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ect aims for a nationwide reach using Internet connectivity available over large parts of India as well as the cellular network which has a broader coverage. The system will support a variety of wireless Internet access technologies such as GPRS, 3G, CDMA, WiFi and WiMax, in addition to broadband connections over landlines.

Facilities for supervised evaluation will support virtual schools prior to certification of students. Online schools could also prepare students to benefit from open school systems that certify students on the basis of their tests/examinations. The solution will also give access to all open educational resources as well as to commercially available content. Moreover, courses offered/supported over the network can be frequently updated. Educational content on the Web has enormous variety, supporting every learning style.

Addressing the problem of a talent gap in the population, the future school will enable students to learn what they need and when they need it. Students will be allowed to study in job-oriented courses along with academic courses if they wish to, after attaining a specified minimum of academic requirements.

The fact that everyone involved in the system can share in revenues to the extent of their contribution will offer incentives to good teachers and organizations to participate. Students would be free to choose among the many institutions and teachers on the system and this will promote quality and affordability.

HP has visualized the system with an infrastructure covering technical as well as organizational/business requirements. It will allow a large number of players, individual teachers as well as organizations, to share the technical facilities without being regimented about their objectives, area of work, style of teaching, or fees. It will enable teachers to contrib-

ute individually or through organized institutions, groups, and companies. It also allows learners to get private tuition without having to commute.

#### TECHNOLOGY CHALLENGE

The first challenge is the creation of a specialized infrastructure of educational software systems and tools, providing ease of access to quality educational content. This infrastructure should enable every group sharing the infrastructure to benefit from advanced personalization facilities as well as evaluation and feedback mechanisms. The second challenge is to create a huge cloud-based system providing computing, storage, and communication resources on a massive scale. It should support the operation of a large number of separate groups to

use by students; a large fraction of these will be owned by families, schools, and other teaching institutes. The complexity of current operating systems and their interfaces is a major impediment to the use of ICT in education. Hence, devices with simpler interfaces are required for students to use them intuitively at various levels.

The education sector is a fast growing segment because a large and increasing fraction of the population (30%) in the emerging markets is of school and college students. Non-availability of qualified teachers is another impediment to the spread of quality education. An increasing number of students are availing distance education, but level of educational achievement possible with distance education remains low in India.

**The future school will facilitate teacher-student interaction for every learner to utilize services of the best teachers to get quality education from anywhere at affordable cost while encouraging a competitive environment for teachers to innovate new techniques in teaching.**

benefit from the common infrastructure; it should also offer them the freedom and flexibility to grow at their own pace on the technical resources involved. In other words, virtual school provisioning should be easy, enabling flexible assignment of requisite types and quantities of computing resources to each group. It should also enable users to choose specialized software and middleware for running an online school.

Another challenge is the availability of a large number of affordable, easy-to-use, robust, and easy-to-maintain devices for Internet access that will be needed for

All these factors indicate that there is a need for new channels of education service delivery to large student population which can give quality education. The challenge is to invent new models for public-private partnerships to serve the education field. New taxation and regulatory policies will be required and a regulatory mechanism will need to be created.

The Future School will provide a perfect platform to connect government policies and India's middle class expectations in return for their willingness to pay for good education. **tr**



## EDUCATION

# Online Communication Aid for The Deaf

Signntalk web portal provides an online interpreter to convert sign language to speech and visa versa, connecting the deaf with the hearing world.

To ensure inclusive growth in our society, it is important to include persons with special abilities into mainstream education, employment, and social life. In India there is a barrier between the deaf community of nearly 10 to 15 million people and the hearing world, and therefore the former has been unable to be part of many social activities. The real issue in India is the woeful inadequacy of facilities for the deaf. Many organizations that work towards equal opportunity and equal rights are unable to recruit deaf candidates due to either their lack of education or lack of infrastructure solutions to include them.

Education for the deaf is a grave concern. Though India has many schools for the deaf, majority of students from these schools are functionally illiterate. Even on completing the high school, a deaf person can barely read or write English properly. The main problem preventing them from getting proper education and employment is the communication gap between the deaf and the hearing world. Signntalk.org is a step towards creating an inclusive environment for the deaf in the country by bridging the communication barriers.

BarrierBreak Technologies and the Deaf Way Foundation have jointly developed Signntalk website, a unique platform that enables the hearing impaired

## Highlights

**Solution Architect:** Ramya Venkitesh

**Company:** BarrierBreak Technologies

**Challenge Summary:** Education is at crossroads today. How to make education useful?



community to connect with friends, families, associates, and colleagues across the world using sign language at which they are at their best while communicating. The platform requires a deaf user to possess a computer with Internet connectivity to log on to Signntalk website and a decent Web-enabled camera to show the user's signs. However, not everyone knows sign language and that is the primary reason why a hearing impaired person has problems communicating ideas or thoughts effectively. To plug this gap, the Signntalk website provides online interpreting service that acts as a connecting solution.

## HOW IT WORKS

The Signntalk requires the deaf caller to register on the website and log in using his or her username and password. The caller is then required to fill in the call details, such as name and phone number of the person, and connect to the



Signntalk interpreter. As soon as the caller connects to the interpreter a service agent gets connected online with the caller from a remote location. The sign language interpreter connects the caller to the desired contact number through a telephone. The interpreter then interprets signs of the deaf caller and communicates the messages in speech to the other receiver and visa versa. Signntalk enables the deaf to order pizza, take doctor's appointment, talk to friends, contact helplines, and do more of what wasn't earlier possible for them to do independently. **tr**

# Game-changing



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ENERGY

# Smart Power Management

Smart power strip can accurately identify when and where electricity is being wasted and switch off the energy-guzzling plug points remotely.

There is a causal relationship between energy consumption and economic growth. Higher economic growth implies greater consumption of energy which in turn implies higher carbon emission. However, developing countries cannot stop their growth for minimizing carbon emission, the primary reason why the 2010 Copenhagen discussions fell through. There is a need for new solutions that can enable growth without compromising environmental concerns.

We can save energy in three ways: By using the devices that consume less energy (for example, LED light); avoid energy wastage; and by enforcing policy that puts a cap on the energy usage by an individual or by an enterprise. The main issues which need to be resolved to achieve the last two techniques are to detect when and where energy is wasted and how to enforce a policy to limit consumption. The current electricity infrastructure does not have any provision for tracking energy wastage on individual scale. Moreover, the present infrastructure is not integrated with information technology through which government could monitor and remotely control such wastage by using a device, such as a mobile phone, desktop computer, or any other handheld device connected to the Internet.

The smart power strip (SPS) solution from Infosys is capable of accurately identifying when and where electricity is

## Highlights

**Solution Architects:** Kumar Padmanabh and Sanjoy Paul

**Company:** Software Engineering and Technology Labs, Infosys Technologies

**Challenge Summary:** India's current per capita energy consumption is among the lowest in the world. Its current generation capacity is 147 gigawatts. Based on growth estimates, India will need to add 280 GW by 2022. Our 2022 energy requirements can be met by utilizing just 1 percent of the incident solar radiation. The major challenges with current solar technology are the poor efficiency of solar cells and their high manufacturing costs. Also, there is a need to innovate and make more efficient machines that consume lesser energy. How to make solar-PV based power 50% cheaper than the current costs? How to increase grid-interactive solar capacity to 100 MW? How to lower the power consumption and improve energy efficiency by 30%? New technologies that can lead to 1 billion units of annual savings?



being wasted. It is even equipped to take action to eliminate such wastage. The SPS monitors a variety of ambiance parameters, such as movement, light, sound, and temperature to identify whether energy consumption can be avoided, and if so, it can turn off the relevant devices. Similarly, based on the temperature and the presence of natural light in an enclosed area, it can decide whether air conditioning needs to be switched on or off.

A large area can be covered with multiple such SPS units which can communicate amongst one another using wireless sensor network technology and use multi-hop wireless routing to send data to a gateway that consolidates the information and forwards it to a portal on the Internet. The portal, which can be

accessed from anywhere using any device, provides the interface to both monitor and control energy consumption. In addition, the devices can be scheduled to switch on or switch off at specific times.

Although researchers have developed the technology in a power strip, they say the same technology can be incorporated inside the legacy switchboards as well. Thus, even legacy appliances can be connected to the consumption points, transforming them into smart appliances with monitoring and control capability just as their smart counterparts. Smart power strip can be used as a normal power strip in which various appliances can be connected.

A SPS comprises an electronic circuit to calculate the voltage and current con-

sumed at each plug point. Algorithms are executed in a microcontroller to calculate the power factor of devices plugged into the sockets, enabling the calculation of electricity consumption in every plug point. Moreover, electricity consumption can be controlled by switching on or off the devices connected to the plug points using relays. The system has USB, Ethernet, and Zigbee interfaces to communicate with the outside world.

The SPS can transform the existing electricity infrastructure into a software-controlled smart infrastructure. Various kinds of software applications can be built on it. For example, one can communicate with the appliances connected to the smart power strip using instant messaging (IM) just as one would communicate with an individual. One of the biggest advantages of SPS is its application in smart grid for supporting demand response mechanism. Currently, in a city environment when the demand of electricity is more than the supply, the energy/utility service provider forces consumers in a neighborhood to shut down all of their electrical appliances, a phenomenon commonly known as load shedding. Smart power strip enables selective load shedding, which means that only select appliances are turned off at the peak load times as chosen by consumers participating in the demand response (DR) program. This brings down the overall



**SMART SOLUTION** Infosys has developed an iPhone application through which users can access and control smart power strip from anywhere, anytime.

demand below the available supply as well as avoids complete blackout of a particular area.

Smart power strips can also be used in an enterprise's smart space management program, whereby the enterprise can monitor the occupancy of cubicles and turn off the computer monitors, VOIP phones, and lights connected to their sockets when cubicles are not occupied. An enterprise level energy consumption policy can be imposed to ensure that every employee has a particular daily, weekly, and monthly energy budget. This can

change the behavior of employees of an enterprise and avoid wastage of electricity.


#### INSIDE OUT

There are three components of a SPS: hardware, middleware, and the application. Each SPS has a potential transformer (PT) to cut down the voltage consumption, a current transformer (CT) to bring down the current consumption, and a microcontroller to compute the power factor. Output signals from PT and CT are processed through signal conditioning circuit and are passed to the

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The earth's population will *increase by 150,000 people per day* for the next 40 years, which means the world will *need to increase food production by 70% in that same period*—even as the relative number of acres that can be cultivated globally shrinks. To feed our increasing numbers, we will need to find ways to grow more food per acre.

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microcontroller which samples these signals at 1 kilohertz and computes the root mean square voltage and current as well as real and apparent power factor. In addition, there are temperature, movement (PIR), sound (MIC), and light sensors. The data received from smart power strips is processed and analyzed at the central server which stores the history of each smart power strip.

The middleware component of SPS connects the device to the outside world. The middleware stack (named MoJo) converts a real wireless sensor-based network to a virtual network of Java objects. The MoJo platform exposes a Java-based application programming interface to developers so that they can write applications without being aware of the functioning of the underlying wireless sensors. MoJo also ensures that power strips are networked together and enterprise level energy consumption policies can be applied. There are many APIs exposed for various functions on a power strip. For example, there are APIs for getting a list of power strips, renaming a power strip or an individual socket (or plug point), getting the current consumed by a power strip or an individual socket, getting various sensor values on the power strip, switching on and off individual socket, and more. Any software application can be built using such API.

Researchers at Infosys have developed a Web-based application that can be accessed through Internet and an iPhone application to access SPS. Like an email or a Facebook account, the user will have power management account on the Internet where he or she can monitor and control the power being consumed in his or her house or office. If someone is present at home, the application allows SPS to use discretion whether or not to turn off appliances at home. The application also throws an alert when a critical appliance like a geyser is on for some time. One can then go to the control panel and



**ACCESSIBILITY**  
iPhone app for smart power strip.

turn off the geyser remotely.

#### CHALLENGES

Some of the technology challenges related to SPS are measurement of power, that is, computation of power factor by sampling current and voltage and measurement of voltage over a wide range of inputs ranging from 110-220 volts. Controlling the plug points is another challenge. Reception of messages, interpreting them, and activating the relays; protection of appliances connected to plug points against surge in power supply; software fuse to cut off power even before the actual threshold is hit are key issues to deal with. Other challenges include dynamic creation of wireless mesh network; multi-hop energy-aware routing; converting physical wireless motes to Java objects; collating, calibrating, filtering and aggregating data from multiple sensors; automatic detection of smart power strips as they are plugged on the wall socket and devices are plugged into the power strip; creating a visually appealing and easy-to-use intuitive Web-based interface; and developing a simple to use application for mobile handsets to monitor and

control devices connected to the smart power strips.

There are several economic challenges for the SPS depending on its application domain and market segment. If the smart power strips are targeted to residential users, then they must be inexpensive enough for consumers to get the return on investment in less than a year. For example, a five-socket power strip should be priced between \$25 and \$40 for mass market adoption. However, providing all the monitoring and control capabilities within that price point is tough. For the commercial segment, the economic benefit is more than the savings in electricity bill. Huge benefit entails from the fact that the smart power strips will enable enterprises to meet their target carbon footprint thereby helping them brand their corporation as “green” and “sustainable”. Thus, corporations will be willing to pay higher premium than the residential market.

When positioned for the energy or utilities market, the economic challenge will be to incorporate smart demand response resulting in the energy or utility service providers giving better than existing rate to those customers that participate in DR program. We already see that there are intermediaries between the energy/utility service provider and the residential/commercial customers who are providing this service by requesting consumers to turn off their non-essential appliances at the peak load time and compensating them for their support of the DR program.

The SPS solution has been piloted in Infosys campus. When a cubicle is not occupied for a duration of more than 10 minutes at a stretch, the light, phone and monitor connected to the smart power strip are switched off. This is done by running business logic in each power strip. The project helped Infosys gain significant savings in energy bill (approximately 10 percent) and reduction of carbon footprint. **It**



HEALTHCARE

# Delivering Health Care on Phone

New technology platform can make Internet content and services available to the masses from low-end mobile phones.

One of the major challenges in developing countries like India is to make health care accessible to rural areas. Seventy percent of rural areas in India lack hospitals, physicians, and medical equipment. To address this lacuna, many government funded projects set up rural health centers with a connectivity to a central hub of expert doctors. There are approximately 4,000 such community health centers (CHCs) and 25,000 primary healthcare centers that aim at providing specialized medical care in India. However, for effective functioning of these projects, providing anytime, anywhere access to important health-related information for health workers is crucial.

With the growth of the Internet, several healthcare portals are now available to provide appropriate solutions to common problems. However, information technology adoption, particularly in rural

## Highlights

**Solution Architects:** Geetha Manjunath, Revathi MM, and Sudhir Dixit

**Company:** Hewlett-Packard Labs India

**Challenge Summary:** Seventy percent of Indian population is in rural India and majority of these rural areas lack hospitals, physicians, and medical equipment. The country has less than 25,000 primary health centres (PHCs) and these are in poor conditions. Another issue is maternal healthcare. India alone accounts for a quarter of the global burden of maternal deaths with nearly 136,000 women dying annually due to causes related to pregnancy and childbirth. How to make specialized healthcare accessible to 25,000 PHCs in the next two years? How to reduce the total cost of consultation to less than ₹ 10 per session? What are the technologies that can help reduce India's share of global burden of maternal deaths to less than 5%? What are the smart healthcare systems that can help register 90% of all pregnancies?



areas, is very low. Internet penetration in India is less than five percent and computer adoption is just nine percent. On the contrary, there is huge growth in the mobile phone usage in India and other

developing countries. India has more than 700 million mobile phone users, which is nearly 40 times the number of Web users in the country. On the flip side, more than 50 percent of these phones are

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ultra-low-end handsets with just voice and text messaging capabilities.

To meet this demand, Hewlett-Packard has developed an application called SiteOnMobile that delivers Internet experience over low-featured phones. It helps patients, doctors, and pharmacists access and upload healthcare related information through either a message or by use of voice. The application does not require users to have any sophisticated computing skill set to upload or access content. A Beta version of the solution was made available in July 2010 at [www.siteonmobile.com](http://www.siteonmobile.com) and a pilot project is currently on, enabling voice and text-based access to Indian consumers with low-end phones. The pilot is planned to be expanded for rural health care in Orissa to monitor the health of pregnant mothers and infants under the ASHA initiative.

#### HOW IT WORKS

There are several small and medium businesses in India that have invested in e-commerce Web portals for their businesses, but they have been unable to leverage from such portals. The SiteOnMobile is a cloud service that enables such website owners to define specific tasks on their website, such as “Buy Solar Stoves”, and make those tasks easily accessible to their customers using low-end mobile phones. The key idea is to view the Web not as a set of websites or web pages but as a set of Web tasks that one would want to frequently perform. HP has introduced a concept called Tasklets that are special type of task-based widgets which can be created by a user by just “showing the action once on the browser”. The user needs to perform the Web task on multiple websites using HP’s special browser and the system then automatically generates a widget-like interaction for that task.

A tasklet basically models a Web interaction as a sequence of Web actions needed to perform the task on different



**MOBILE HELP** SiteOnMobile allows users to create and access tasklets in the cloud.

web pages. These tasklets are hosted in a cloud service and hence can be executed on diverse thin clients. For example, if a user creates a tasklet of “Book a Taxi,” he or she will get an access code. The next time the user wants to book a taxi he or she need not go through several Web pages to reach the booking page. The application will do all of it for the user internally and serve the booking page on the user’s phone screen instantly. The user could also use voice access code to book a taxi.

The tasklets can be accessed by users over SMS and voice services. The message text sent from the mobile device provides the details of the Web task that needs to be executed and the system performs the task on the cloud and sends back the result over SMS. For example, if the user sends an SMS “weather bangalore” to a predefined SMS access code, he or she will receive back the weather information from [weather.com](http://weather.com).

Mobile phone users can also access these tasklets through an interactive voice recognition (IVR) interface. Once a user dials the access code, an IVR application provides voice menu and sub menu dialogues and enables the user to select the task and get results.

Essentially, there are two classes of

target users for the SiteOnMobile solution: The website owners who would be interested in enabling new content/services over SMS or voice can expand their reach (for example, hospitals, medical practitioners, pharmacists, community portals) and the consumers who would be interested in accessing specific (health-related) Web content or service using low-end mobile phone (by using either voice or SMS).

#### BENEFITS

SiteOnMobile can enable healthcare centers in rural India, which lack infrastructure to provide specialized doctor consultation to their critical patients, to easily access the valuable healthcare information from hospitals’ Web contents and services using a low-end mobile phone. The solution can also allow patient’s medical data such as glucose level and blood pressure information to be uploaded by using a mobile phone and sent to a city doctor for monitoring patient parameters and medication advice. This particular use case is currently under development and is planned to be first used for Malaria control in Orissa. The health data will be updated by health workers who regularly monitor health of such patients during the treatment period. **tr**



INFRASTRUCTURE

# Automated Traffic Management

Existing mobile communication technology can be used to overcome traffic management woes.

In the recent past, several automated solutions have been deployed to enforce traffic regulation. For example, cameras on the junctions to monitor signal jumps, speed interceptors, camera enforcement for lane discipline, evading toll payment, and so on. Though such automated solutions have helped in reducing the number of road accidents and casualties, they still fail to address many issues related to technical, financial, operational, and legal aspects, such as dependence on good weather conditions for road cameras to click clear images; acceptance of the images captured as evidence in courts; partially automated system resulting in an overhead of employing more resources to operate the system; public acceptance and lack of awareness; overhead cost and planning in deploying new infrastructure on roads; and privacy issues.

The automation provided by existing systems is not sufficient to ensure hassle free traffic movement on the road. It also fails to deliver the benefits of an automated system due to continued dependence on manual intervention. Nokia Siemens Network has developed an automated traffic management solution that integrates various existing technologies to give a comprehensive solution to traffic management problems.

## THE CONCEPT

The proposed solution introduces a new smart key, which is the driver's license

## Highlights

**Solution Architects:** Malavika Sujith and Lakshminarasimham G.

**Company:** Nokia Siemens Networks

**Challenge Summary:** The overall infrastructure in India, be it physical connectivity or basic utilities like power, ports and highways, is inadequate and constrains most of the industries. Since the past two decades while the urban growth has been exploding, the quality of urban life has deteriorated. There is an urgent need for creating a vibrant, efficient, and sustainable urban infrastructure. How can we make the administration responsive to provide effective services 24/7? How do we make our cities smarter with integrated systems and reduce energy consumption by 50%, traffic density by 50% and crime by 50%?



with a chip embedded on it containing basic details of the driver, such as name, age, address, blood group, driver's license information, insurance details, and more. This smart key interfaces with the mobile communication unit (MCU) which is installed in the vehicle. The MCU is capable of capturing information from the car and transmits and receives data via the existing 2.5G/3G wireless infrastructure. The MCU provides the information required by the traffic management system periodically to the central management server. The central management system processes the information received by the MCU and takes appropriate actions. The setup also includes an interceptor, which is installed at strategic places in the city to detect vehicles without the MCU.

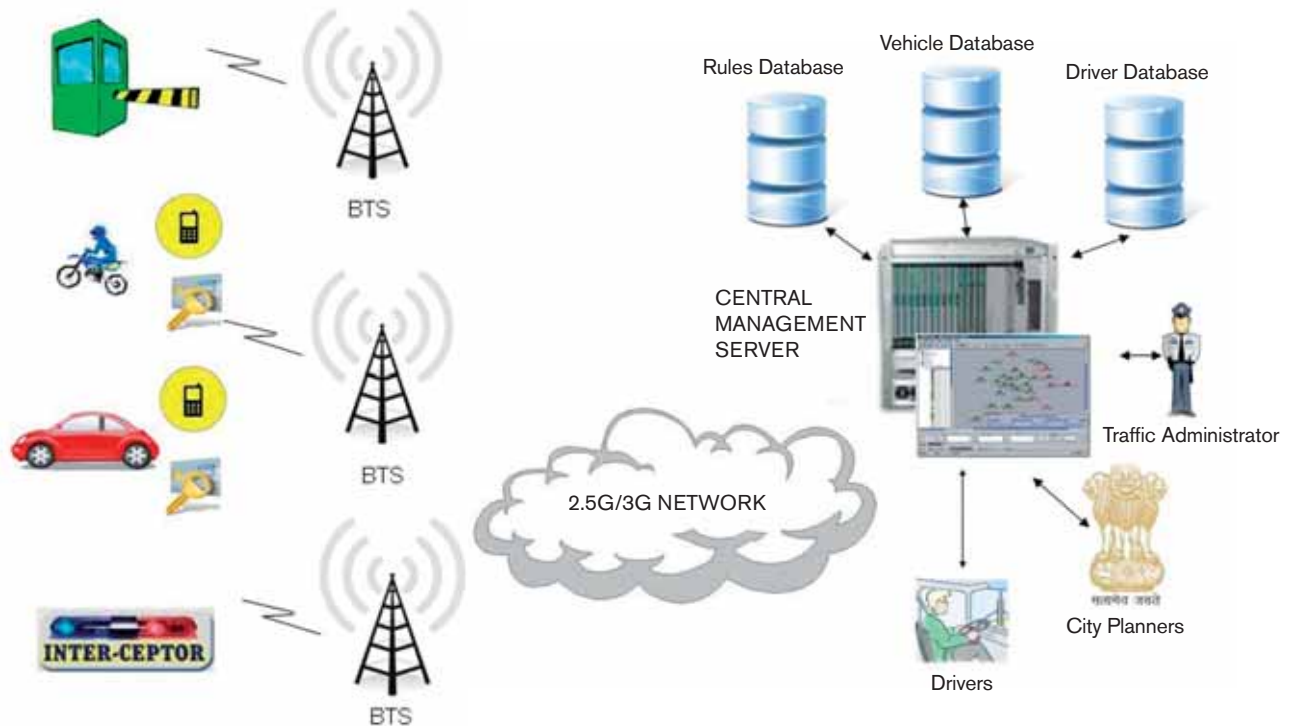
In addition to the main features, the

system can provide additional services such as give live traffic update, both on a website and via push messages to mobiles, collect toll, track stolen vehicles, and more.

The central management server would have a standard interface towards the network, thus making the automated traffic management system versatile. This leaves scope for new technologies to be integrated easily as and when they evolve. The MCU provides the speedometer value in the vehicle at any given point of time, location of the vehicle at that instant, type of the vehicle, and the driver's details. With this information the central management system can accurately conclude if there were any violations caused.

The automatic traffic management system allows central management sys-

## AUTOMATED TRAFFIC MANAGEMENT NETWORK



tem to determine the direction of the moving vehicle by recording two consecutive positions of the vehicle. If the direction it is moving in is not according to the rules, it reports to the complaint monitoring system. Since the central management system controls the signals, it is also equipped to track vehicles which jump signals.

### REAL-TIME FEED

Real-time data coming from all the vehicles on the road indicate the extent of congestion accurately. Hence this can act as a feedback loop within the management system to operate the signals in an optimal way which would decongest the traffic. This information can also be transmitted to the road users to indicate which routes are currently blocked. An integration into other navigation tools to indicate realistic times to reach a destination is also possible.

The solution provides multiple benefits such as fully automated traffic management system which can address all aspects of enforcing traffic rules; significant cost savings resulting from elimination of the extent of manual effort involved; cost-effective and quick solution; and accurate planning and adaptive management of traffic.

### TECHNOLOGY CHALLENGE

Most existing automated traffic management systems rely on sensors and automatic visual identification of vehicles. These techniques tend to be more expensive, less accurate, and do not work in all weather conditions. There is also an element of maintenance involved in such systems. Hence, the technology challenge is to set up an automated system which can enable more accurate and reliable information for enforcement of traffic rules as well as provide a cost

effective solution.

The proposed solution does not introduce a new technology but describes how the existing mobile communication technology can be leveraged to overcome the challenges described earlier with automated traffic management system. By introducing a reliable and tamper proof mobile communication unit in the automobiles, it is possible to collect information required for all kinds of traffic rules enforcement. The mobile communication unit is supplemented by a smart key which can act as a key to the vehicle and also provide the automated system information about the person who is driving the vehicle. Current automated systems lack the ability to identify the driver when the offense is committed and therefore there is no enforcement of rules, such as automatic license suspension in case of repeated offense. **tr**



WATER

# Low Cost Water Purifiers

New cost-effective water purification technologies remove microbiological, arsenic, and fluoride contamination from drinking water without being dependent on electricity.

India faces an enormous challenge in providing its citizens with clean potable water free from pathogenic bacteria, viruses, and cysts which cause diseases such as diarrhea, cholera, typhoid, and amoebiasis. It is estimated that about 10 million illnesses and 700,000 deaths in India could be attributed to diarrhea of which 400,000 are children under the age of five. Moreover, due to over exploitation of ground water, the levels of mineral contaminants such as arsenic and fluoride in water drawn from wells have increased dramatically. High levels of arsenic in drinking water causes serious and sometimes fatal health problems such as nervous dysfunction, cancers of the bladder, skin, kidney, liver and hyperkeratosis of the palms and feet. Consumption of water containing high levels of fluoride causes dental as well as skeletal fluorosis — a

## Highlights

**Solution Architects:** Chetan Malhotra, Dilshad Ahmad, and Shankar Kausley

**Company:** Tata Consultancy Services

**Challenge Summary:** India like many other nations will face a dire water crisis in the coming years. According to some experts, in India, we treat only 33 percent of the wastewater that is produced. Another challenge is achievement of zero discharge in industries especially in terms of liquid wastes. How to treat 100% of the wastewater that is produced? How to achieve zero-discharge of liquid wastes from the industries into water bodies? Simple water purification technologies which have least dependency on electricity?



crippling bone disease causing severe deformities in adults as well as children.

About 50 million people in West Bengal are presently affected by arsenic poisoning while an additional 70 million people are affected in neighboring Bangladesh which according to the World Health Organization (WHO) is the larg-

est mass poisoning in human history. In addition, about 60 million people across India, mainly in Rajasthan, Gujarat, and Andhra Pradesh consume water with high fluoride content. Given the gravity of the situation, there is an urgent need for deploying technologies for removing microbiological, arsenic, and fluo-

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**3,000**

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ride contamination from drinking water before it is consumed. Researchers at Tata Consultancy Services Innovation Labs are developing water purification technologies appropriate for India. The team believes the most appropriate technologies for water treatment in India are those which do not require electricity or regular user intervention. TCS has developed counter-top filters, such as Sujal, a rural water filter, and Tata Swach, one of the world's most economic household water purifiers, for removal of contamination from water before it is consumed.

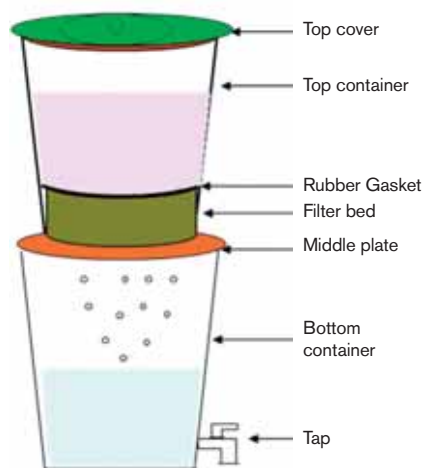
#### PRODUCT INNOVATION

The key ingredient of Sujal filter was a matrix of pebbles, cement, and rice husk ash, a byproduct of the paddy industry which, while had little or no value to the rice growers, was a highly effective filtration medium. The adsorbent capacity of rice husk ash emanates from its microstructure which consists of porous silica and carbon, forming an intricate network of microscopic holes and channels. A complete unit cost only ₹ 200 with a replacement cost of ₹ 25 for the filter bed and could remove 95 percent of the turbidity and bacteria present in the input water.

In 2006, the team developed a novel method for modifying the surface of rice husk ash to incorporate millions of silver nanoparticles into its pores resulting in a material that had greatly enhanced bacteria-killing performance. This material was then incorporated into a compact cartridge which forms the heart of Tata Swach Nanotech Water Purifier. The Tata Swach Bulb is capable of purifying 3,000 liters of water without clogging or losing effectiveness and incorporates a Tata Swach Fuse to shut the flow of water when the bulb reaches the end of its useful life.

One of the most effective and economical methods for removing arsenic contamination from water involves

### RURAL WATER FILTER



coagulation, flocculation, and separation. These steps are commonly employed worldwide in municipal water treatment plants by employing large-scale batch processing equipment. TCS' household arsenic filter prototype is capable of condensing the same steps to fit in a counter-top package. A compact float and siphon based metering system adds fixed amounts of coagulant to water. This coagulant then forms a dense floc or precipitate which reacts with the arsenic present in the water thus trapping it in a stable complex. The arsenic laden floc is then captured in a floc collection and adsorption system while clean, arsenic-free water flows down to a collection chamber. The fluoride removal solution incorporates a novel coating on rice husk ash to generate a high capacity adsorption medium which is selective to fluoride at specific acidic values. The system also incorporates a pre-defluoridation step to further increase the capacity of adsorption media while simultaneously controlling the alkalinity of the water. Water first enters the pre-defluoridation section wherein a small amount of coagulant is added to it by a solid candle. As with the arsenic removal filter, this coagulant forms a floc which attracts the fluoride ions from the water

and gets captured in a floc collector at the bottom of the unit. Water subsequently flows upward through the adsorption media which removes the remaining fluoride ions and fluoride-free water flows out of the outlet of the unit. Each unit is capable of treating 500 liters of water and four such units are combined to form a 2,000 liter capacity household filter.

The arsenic and fluoride filters are currently undergoing extensive in-lab testing. A prototype of the arsenic removal filter was tested over 3,000 liters while multiple 500 liter capacity fluoride removal units were tested against challenge levels of 10 parts per million of fluoride. The output levels of arsenic throughout the life of the filter are within the 10 parts per billion limit set by the World Health Organization (WHO) and Indian standards while the fluoride removal unit is capable of reducing the levels of fluoride ions present in the input water to below the WHO and Indian standard limit of 1.5 parts per million over its prescribed life.

#### BENEFITS

Sujal has been deployed across 30,000 rural households in India while Tata Swach is now available in shops and stores across Maharashtra, Karnataka, West Bengal, Madhya Pradesh, and Uttar Pradesh with subsequent launches planned across the country. By enabling their users to consume bacteria and virus free water, both Sujal and Swach are playing an important part in reducing morbidity, illness, and fatalities due to waterborne disease.

While Sujal is the first "make it yourself" rural water purifier, Tata Swach broke the price barrier in India for affordable household water purification (priced at ₹ 999). Subsequently, two more variants costing ₹ 749 and ₹ 499 have been launched thus starting a revolution in low-cost water purification in the country. **tr**