Genesis of Aakash 2

Kannan M Moudgalya & D B Phatak* and N K Sinha & Pradeep Varma**

*Indian Institute of Technology Bombay
**National Mission on Education Through ICT, MHRD

This is a reprint of an article that appeared in CSI Communications, pages 21-23 and 29, January 2013.

On 2 Feb. 2009, the then Human Resource Development Minister Shri Arjun Singh inaugurated at Tirupati the National Mission on Education through ICT (NMEICT) with an outlay of Rs. 4,612 crore, equivalent to one billion US$ at the prevailing exchange rates. Out of this sum, about 60% was allocated to provide good bandwidth to universities and colleges and the remaining was meant for content development and a low cost access and computing device. The objective of this mission was to raise the levels of education in India. It was an initiative of the Department of Higher Education, MHRD, Government of India.

The National Programme on Technology Enhanced Learning (NPTEL) had just completed the first phase with instructional material on 240 courses. This success had demonstrated that it was possible for the educational institutions to work together to deliver products of common good.

The team behind NMEICT believed that a lot could be done for education using information and communication technologies. There was a need to develop NPTEL like courses for all subject areas: science, arts, social sciences and commerce, by the best people from all universities and colleges. To support theory, and to increase the motivation levels, virtual labs and robotic devices were proposed. In order that the technologies and the content are accessible to everyone, use and promotion of open source software was mandated. To stream the content, extensive plans were drawn up to provide bandwidth. A low cost access device was proposed as the delivery vehicle.

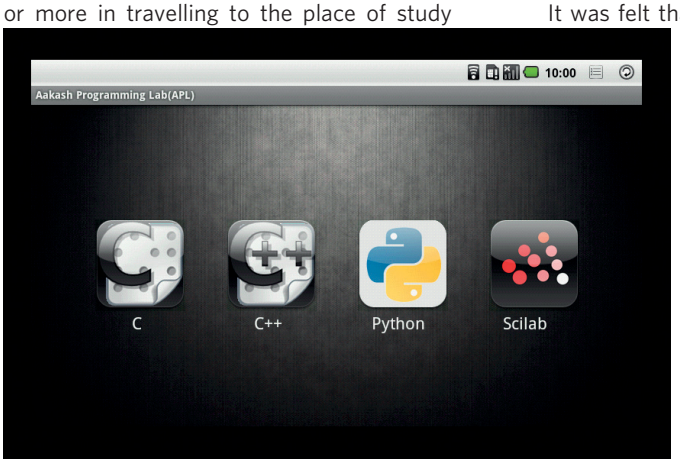
Statistics revealed that a large number of college going students spent two hours or more in travelling to the place of study every day. At least a few of them would be interested in using that time for learning purposes. If recorded educational videos were available on a tablet device, the students could listen to them while travelling between their homes and colleges.

It was not necessary to spend money on software development specific to the device, such as a unique operating system - Android or Linux should do. The operating cost could also be kept low by avoiding the use of proprietary software packages. A rich software ecosystem could be provided through the promotion of open source software. Necessary funding to train the students and faculty on the use and creation of open source software could be provided separately through the content development budget head.

Having a computing system on the go would allow students to try out their ideas even while on the move or during a group discussion, etc. Such a device should allow students to validate their ideas through small programs, which if worked, could be transferred through a cloud to a high-end computing system.

It should be possible to use this instrument as an access device, for getting on to the Internet, for browsing and for writing emails. It should be possible to open and read documents created in standard format, such as pdf, odt and doc. It should be possible to use this device for entertainment: to play games or watch videos.

Subject to the above requirements, the device should be at the lowest cost possible, so that a large number of students could easily be accommodated, in case of subsidized distribution programs.



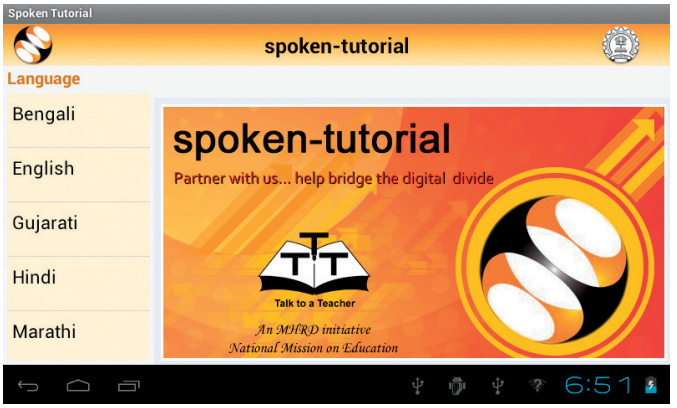
It was felt that a tablet based on a low cost ARM processor could meet all the above mentioned requirements. Instead of going to the latest, one could profitably use the components that were just past their prime, as these provide the best performance to price ratio.

Experts from IITs, IISc and the industry helped the government arrive at the specifications for the proposed low cost access and computing device. It was estimated that the bill of materials for the absolute minimum configuration required to meet the above capabilities would be about $35. It should be possible to get such a device for sub $50 to start with and eventually to sub $20 levels. The already existing solutions like the one laptop per child would have cost in excess of $150 and hence would have been prohibitively expensive, given the hundreds of millions of students in India.

The task would be entrusted to a group of educational or research institutions, led by an Indian Institute of Technology. This IIT would place an order for 100,000 devices based on a global tender. It would verify whether the proposed hardware configuration was sufficient to make the instrument a reasonable computing and access device. It would arrive at this conclusion by testing this device at a large number of educational institutions. In this process, this IIT would also establish a huge ecosystem in many colleges and universities, required to port and support the software that would eventually run in the device.

Unfortunately, almost no one believed that the proposed low cost model was viable. The then prevailing high costs of tablets made many to disbelieve the proposed approach. Some even went to the extent of casting aspersions on the people behind this project. Vested interested groups that stood to lose by the success of this project were the other adversaries. As it involved mostly developmental work and not basic research, most institutions were reluctant to lead this project. Even those who had the necessary background and interest in such a project were busy with prior commitments.

IIT Rajasthan was the only institution that was ready to give this project a try. IIT Rajasthan followed an open tender process. A three step process was followed to evaluate the bids that were received. First, a committee scanned all bids to check their eligibility based on the conditions specified in the tender. Next, a technical evaluation committee comprising eminent academics and industry experts evaluated the eligible bids. In the third stage, the bids that were found technically suitable underwent financial scrutiny to identify the lowest bidder. The company Datawind emerged as the lowest cost bidder. On further negotiations, Datawind agreed to supply these devices at a landed price of $49.98. Custom and excise



duties would be waived.

The device that Datawind agreed to supply had the following specifications: 366 MHz Conexant ARM 11 processor, 7" resistive touch screen, 256 MB RAM, two USB ports and wifi.

Many criticized the Government for holding on to the price point of $50 when the idea of low cost access device was contemplated. It should be pointed out that there is no correlation between the selling price and the cost of production in the electronics industry. If the Government were not stubborn, the price would easily have escalated. The sub $50 order resulted in a saving of at least $50 per device and hence a net saving of about Rs. 25 crore, even on an order of 100,000 units. The savings would be a lot more when millions of students are covered.

It should be pointed out that no established manufacturer in the field of computer tablets or CPUs was willing to participate in this activity either directly or indirectly. There were two reasons: if the project went awry, their reputation would take a hit. If on the other hand it was a success, the margins in their other product lines could be severely affected.

On the other hand, for a new or a first generation entrepreneur, the loss of profitability of an existing product line was not applicable. They would also go for the most efficient way to produce the goods as the margins were small. The possible establishment of their brand would be the driving force to take the necessary risks.

The low cost access and computing device was christened Aakash and was launched on 5 Oct. 2011 by the then Human Resource Development Minister, Shri Kapil Sibal.

Unfortunately, however, differences between Aakash and what people expected it to be arose. The public compared this device with the ones available in the market, which were several times more expensive. On the flip side, the latter, although expensive, were only access devices, but not computing instruments.

In order to bring Aakash closer to people's expectations, the specifications were redrawn in a meeting held between MHRD, IIT Rajasthan and Datawind in Nov. 2011. In this meeting, Datawind agreed to provide a capacitive touch screen in lieu of the resistive screen. They also agreed to provide the tablet at Rs. 2,276, the rupee equivalent of $49.98 on the day the purchase order was placed. This would more correctly account for the delays, while protecting against the fluctuations in the exchange rates. This new improved device was christened as Aakash 2.

In Feb. 2012, IIT Rajasthan informed MHRD that they would like to withdraw from the project. We have already explained the kind of work expected of IIT Rajasthan. Being a new IIT without sufficient faculty strength and with a temporary campus, it was possibly proving to be difficult to handle this project. Expectation management was an unexpected, additional, headache.

By that time, several NMEICT projects were functioning very successfully at IIT Bombay. The e-Yantra project had produced several versions of educational robots and had trained many college teachers and students. The OSCAR team came up with several 3D animations that could be used for instructional purposes. The design content creation project of the Industrial Design Centre created a lot of the state of the art content in the area of design. The virtual labs project had many simulation and remote triggered experiments. The FOSSEE project had created good eco-systems for open source software, such as Scilab, Python, Open FOAM for computational fluid dynamics, OSCAD for electronic circuit simulation and GNUKhata for accounting. The live recording of regular courses of IIT Bombay was ready to be delivered through a web portal. The Spoken Tutorial project was training tens of thousands of students through open source software workshops in hundreds of colleges, free of cost. Many high quality spoken tutorials were also created by this project. The benefits of all of these projects could be delivered through Aakash.

The 1,000 teacher training programme activity, also funded through NMEICT, was possibly the most appropriate one to test Aakash. The Remote Centres of this programme would be the natural testing ground for Aakash. It would be possible to teach thousands of teachers simultaneously on the use of Aakash, software development and support. All the thousands of teachers trained through this programme could be called upon to test Aakash and to give their feedback. Many students in these colleges could be encouraged to carry out their final year project using Aakash.

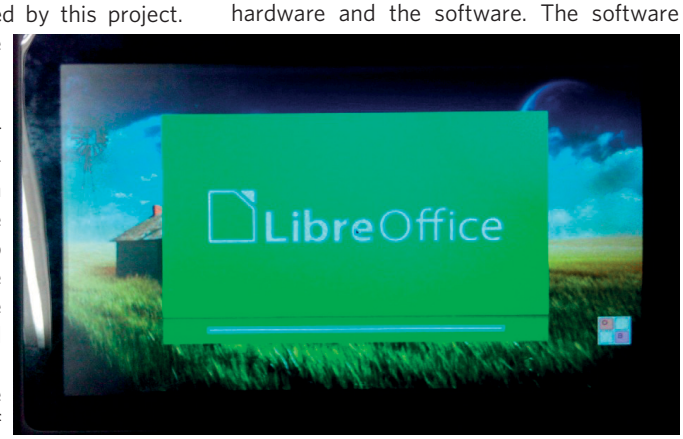
More than 200 staff members were working in all the NMEICT projects at IIT Bombay. As all the NMEICT projects at IIT Bombay had achieved a substantial part of their targets, they could be called upon to transfer the fruits of their projects to Aakash.

In March 2012, the Aakash project was transferred to IIT Bombay, with CDAC as its testing partner.

As IIT Rajasthan selected Datawind through due diligence, following all CAG norms, IIT Bombay decided to procure Aakash 2 from the same vendor. Starting a new tender would have delayed the project by six months to one year. IIT Bombay negotiated with Datawind once again and froze the prices at Rs. 2,263. The specifications of this device are given below: 800 MHz ARM Cortex A8, 256 MB RAM, 2GB NAND flash, 2GB SD card, 7" display with 800x480 resolution, four point multitouch projective capacitive touch panel, Android 2.3 or later. The purchase order was issued on 4 May 2012. Datawind was supposed to complete the delivery of 100,000 units by 31 October 2012.

On testing the devices supplied by Datawind, it was found that the CPU of the device and the Android 2.3 OS that ran on it were not stable. It was required to reset the system very often. The 256 MB RAM that came with the device was not sufficient to port many applications.

In July 2012, Datawind agreed to upgrade the device to a better one without any cost escalation. The new device would have 512 MB RAM, 1GHz ARM Cortex A8 processor, Android 4.0 operating system and a gravity sensor, all upgrades over the purchase order issued by IIT Bombay in May 2012. On testing, it was found that the new device was a lot more stable than the previous one, because of the upgrades in the hardware and the software. The software



team at IIT Bombay also found this device to be a lot easier to port software on to.

The extra time that Datawind had between Aakash 1 and the improved Aakash 2 helped it iron out the raw edges and to give a much better product. This is true of any new product development project: there are always a lot of shortcomings during the learning curve and once the problems are rectified, the product becomes a much better one. Datawind was also given an extension as this was a completely different tablet and hence, tooling, etc., had to be re-done.

During the past six months, a lot of software development work around Aakash has taken place at IIT Bombay and its remote centres. This work can be classified into five categories:

1. **Porting of instructional videos and associated ecosystem:** NPTEL videos and the video recordings of class room lectures at IIT Bombay are now available on Aakash. The 3-D educational animations created by OSCAR and the spoken tutorials are also available on Aakash. While watching a video, one can "ask a question", which gets lodged in a forum and gets answered during a one hour live session every week. IIT Bombay has been running this AAQ activity for more than two years in electrical engineering. An open source software PROXIMITY that helps access videos on the basis of tags is also available on Aakash.
2. **Porting of text books and research monographs in e-pub format to Aakash:** Work is underway to port NCERT textbooks on to Aakash. As the screen size of Aakash is small, one may have to zoom the contents, which would make page width exceed the size of the screen, resulting in scrolling to read every line. The e-pub format re-flows the lines so that the entire text fi ts within the width of the screen. The current plan is to port the textbooks of all school boards. The same activity can be extended to college level textbooks and research monographs that are freely available, an example being the IGNOU content.
3. **Programming and simulation environments:** C, C++, Python, Scientific Python, PHP, Perl, R and Scilab have been ported to Aakash.
4. **Accessing external hardware from Aakash:** Aakash has been used to control robots developed through the e-Yantra project. We have been able to access virtual labs and the physics experimental kit expeyes. Work is underway to build a low cost alternative to ECG systems using an Aakash based sensor system. Work is also underway to build a low cost microscope using Aakash and an USB web camera.
5. **Porting of Linux:** We have been successful in porting different flavors of Linux to Aakash. We have Ubuntu 12.0 running in native mode on Aakash. The performance of some applications is better in Linux, compared to Android. For example, the Scilab port on Android is through a chroot environment, with associated communication delays between the operating systems. On the Linux side, however, Scilab runs in native mode, resulting in a much better performance.

We will describe these in a future article. It should be pointed out that the philosophy of NMEICT that all the instructional material should be made available free of cost to the learner would apply to the above explained resources as well.

When IIT Bombay started the Aakash work six months ago, there were three specific tasks: To confirm whether the idea of Aakash was viable. This is an important question to answer as not many people believed in this concept until as recently as six months ago. IIT Bombay has demonstrated that the idea of Aakash is eminently viable.

The second mandate to IIT Bombay was to create a large number of educational applications locally and also by co-opting students and faculty members of many colleges from all over the country. IIT Bombay is making a lot of progress in this as well. In order to publicize this intent, IIT Bombay is spearheading two competitions on application development for Aakash, one for Android and the other for Linux. Depending on the number of entries, there could be different tracks, such as school applications, home automation, etc., in each of Linux and Android, with corresponding number of sets of prices. An advertisement for this appears at the end of this article.

Several other parallel efforts are also underway to develop applications suitable for Aakash. CDAC is working on providing Indian language support to Aakash. IIT Madras is leading a software development effort by collaborating with several other IITs, including some recently established IITs.

The third task assigned to IIT Bombay was to carryout extensive testing and to get sufficient feedback required to arrive at the specifications of Aakash 3. This work is also in full swing. IIT Madras is coordinating the task of coming up with the specifications for Aakash 3.

One can see that the Aakash project is progressing well. There have been controversies, such as the origin of manufacture, poor hardware quality and delivery schedule. Such problems do arise in any such ambitious project. We are glad that through sheer determination and grit of the Aakash Team, most of these problems have been overcome. We are also glad that Aakash has had a role in lowering the price of tablets all over the world: reasonable quality devices that were available only in the $200-300 range a year ago are now available for less than $100. No top of the line tablet device can match Aakash even today in the computing area.

The Aakash 3 order is expected to be of the order of 5 million. As it will come out about a year after Aakash 2 and as it will be a much larger order, Aakash 3 is expected to deliver a lot more for the same price. Development of a system on a chip, exclusively for Aakash, will be a long term goal of this project, as it will help achieve much lower prices, while simultaneously improving the performance levels. ■

About the Authors

Dr Kannan M. Moudgalya has degrees in Chemical Engg. and Electrical Engg. from IIT Madras and Rice University. He has been a professor at IIT Bombay for 25 years. Through the Spoken Tutorial project, he promotes IT literacy.

Dr Deepak Phatak is a teacher. He has been working with IIT Bombay for over 40 years. He is currently engaged in NMEICT projects to scale quality education using ICT. He is a fellow of CSI.

Mr Narendra K. Sinha, IAS, graduated in electrical engineering with a gold medal and distinction from IT BHU and IISc and an MBA from Southern Cross University, Australia. As Chief Electoral Officer, District Magistrate and Collector, and Transport Secretary and Transport Commissioner in Bihar, he implemented IT solutions to streamline the operations. Mr. Sinha is the Additional Secretary (TEL) MHRD and Director of NMEICT. He conceptualised NMEICT in general and Aakash in particular.

Mr Pradeep Varma is an IT professional and entrepreneur. After a distinguished career in the corporate sector, he has devoted his time to teaching and to serving the National Mission on Education through ICT of the Govt. of India.

Software Development Competition on AAKASH Tablet

All are welcome to participate...

Android experts are welcome

We also invite Linux Enthusiasts

For more information, please visit

http://AakashLabs.org/compete

AAKASH tablet for every indian

Aakash is an initiative of
National Mission on Education through ICT,
MHRD, Government of India,
Currently being executed by IIT Bombay

IIT Bombay