JITTC

Building a high-technology product out of India: The Intelli-Fi way

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Abstract

There has been a constant debate over the last decade as to whether the Indian information technology sector should continue to be driven by services revenue or should the firms actively pursue in building high-technology products. Dr Prashant Joshi, former lead researcher at AT&T Research and IBM Thomas J. Watson Research Centre, New York, while returning to India in 2002, conceptualized that someday, the world would witness massive deployment of WiFi networks and that these networks require active 24 × 7 management. He incubated his start-up in Bangalore, India, with a vision to build a WiFi secure management product suite for global markets. The case outlines the evolution of Intelli-Fi networks from a humble beginning to a strong network management firm with installed base all around the world. The case highlights the technical and managerial challenges of the firm and its entrepreneur founder in building a world class product.

Keywords

WiFi Networks, network management, cognitive networks, India start-up, cloud networks, tech entrepreneurship

Preamble

Dr Prashant Joshi, a lead researcher at AT&T Research and IBM Thomas J. Watson Research Centre, New York, where he was a research member of the then emerging technologies such as Mobile IP, WiFi and Bluetooth, decided to return to his native India in February 2002. While he was in the air from the United States to India, it really struck him odd that while India had become well-known for information technology (IT) services with home grown mammoths such as Infosys, Tata Consulting Services and Wipro, why did she miss the bus on IT products? Is there any disruption that he could create in the area of his passion – that is, communication networking, so that he could show to the world that Indian entrepreneurs could build global products! Although he was flying to India to join his alma mater – the Indian Institute of Technology Kanpur, India as a faculty member, he decided against it and took this risky and adventurous path of being a tech entrepreneur. This turn of events, as an accidental entrepreneur as Dr Joshi euphemistically puts it saw the birth of Intelli-Fi networks, with development centres in his home town of Bangalore in the State of Karnataka in India. After a decade of hard work, his venture became a leader in the provisioning of cloud-based secure and massively scalable WiFi network solutions for enterprises around the world.

The products and solutions from Intelli-Fi Networks have been acclaimed by its worldwide customers:

> How was Intelli-Fi manage to carve out a product successfully in the crowded and commoditized WiFi technology space?

> What were the main decisions that Dr Joshi took in creating a global product out of its development centre in India?

IT services versus product story in India

There has been a constant debate over the last decade as to whether the Indian IT sector should continue to be driven by services revenue or should they indulge themselves

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actively in product business. Recent NASSCOM reports show that product revenue contributes to less than 10% of total IT industry revenue (NASSCOM, 2017). Off-late companies such as Microsoft, IBM and SAP Labs have been shifting their New Product Development to India centres. However, Indian software companies have not been active in product innovation. One measure of product development innovation appears in patent data. A quick look at the US Patent Database (uspto.gov) shows that Indian IT companies are still very far from firms such as IBM (54,365), Microsoft (10,958), and SAP (603) in number of patents awarded.

There are inherent risks to developing software products in India that explains the lack of product development activity. A key determinant of the location of product development activity in software is the location of the user. It is explained by many researchers that whenever a firm is not near to the users, it is difficult to conceptualize the features and functionalities of the product comprehensively and incorporate them into the product architecture (Sridhar and Vadivelu, 2011). This is particularly true with business and technology software in the areas of enterprise systems, mobile communications, and networking technologies. A good example is Israel's long-standing strength in security software, thanks to the advanced local needs of Israeli defence forces. Since India, until now, was not matured enough for the adoption of technology-intensive IT products, the products, if developed, should be targeted at developed markets in the United States, Europe, Japan, Korea and the like. In this case, the firms that develop such products lack visibility on the comprehensive product requirements specifications, and user needs which increases the risk in the development process. Although the domestic IT and telecom markets in India are developing fast and hence provide a testing ground for products, it remains a dilemma for India-based technology firms whether they should at all be involved in developing products.

It is the following thought that provoked Prashant Joshi to venture in to building global products using the technical and engineering skills available in plenty in India:

> I felt that the whole chaotic existence of India is a very fertile ground for creativity. In the Valley everything is so smoothly running, you begin to wonder, what value you're going to add. And while there were several IT companies established in India at that time, they were more IT services based and not technology based.

What product?

In 1985, the Federal Communications Commission – the telecom regulatory body in the United States – prompted by a visionary engineer on its staff, Michael Marcus, decided to open several bands of wireless spectrum, allowing them to be used without the need for a government licence (The Economist, 2004). In 1988, NCR Corporation, which wanted to use the unlicensed spectrum to hook up wireless cash registers, approached the Institute of Electrical and Electronics Engineers (IEEE), where a committee called 802.3 had defined the Ethernet standard. A new committee called 802.11 was set up, to formulate the standard specifications for wireless local area networks (WLANs) that would operate in the unlicensed bands of 2.4 and 5.8 GHz (also called as industrial, scientific and medical bands) approved by the Federal Communications Commission (FCC). This sparked a silent revolution in large US university campuses in the 1990s in research and deployment of WLANs. While many WLAN technologies were built throughout the 1990s, it was the establishment of the 802.11b standard by the IEEE in December 2000, which was later ratified by manufacturers as wireless fidelity (WiFi), which set the stage for mass market development deployment of WLAN products (Prasad and Sridhar, 2014).

Like the Internet and Web, WiFi networks became a mass market technology due to open standards that unleashed powerful competitive forces and innovations. There were an estimated 15–18 million 802.11b devices by 2002. Among the geeks, WiFi became a fascination, a glimpse of the future of the Internet. Like the Web, it is open, unregulated and free. It doesn't require a loyalty oath to the Telecom and Internet Service Providers. Anyone can deploy it and millions did (Anderson, 2003).

While this WiFi revolution was taking place, Dr Joshi who had years of experience in designing wireless products at AT&T and IBM, strategized on riding on this wave. However, by 2004, the WiFi products had become commoditized, thanks to IEEE and WiFi alliance standardization and certifications. Products started selling at low prices with very little margin.

What were the options for Prashant to realize his dreams of building a product? How could a start-up enter and survive in the market where products are already standardized and commoditized with razor thin margins?

Furthermore, should Prashant and team build a product for Indian market which was in the very early stages of WiFi adoption or for global market? If it was indeed for global market, how could the start-up compete with large multinational firms to garner any market share?

The first big idea: securing wireless networks is the key for enterprises

However, there was an interesting opportunity sensed by Prashant. By their very design, WLANs afford open access. Similar to cordless phones, they use radio waves to transport data. Unless security is enabled, these signals can be readily intercepted by nearby receivers. The IEEE 802.11 committee standardized wired equivalent privacy (WEP) which was found to have many weaknesses. The first practical attack on WEP was identified by researchers Scott

Fluhrer, Itsik Mantin and Adi Shamir, who found that, even with WEP enabled, third parties with a moderate amount of technical know-how and resources could breach WLAN security (WiFi Alliance, 2003). Subsequently, the WiFi alliance introduced 'WiFi protected access (WPA)' that addressed the vulnerabilities of WEP encryption–enhanced user authentication schemes.

Although the aforementioned security standards provided reasonable protection for individual users, they were inadequate for enterprise security and protection. Prashant recognized the need for wireless intrusion prevention systems (WIPS), which is cost-effective, scalable and accurate.

However, Prashant was aware that there are hundreds of such security products in the market, some of them from network pioneers such as Cisco:

> How could Intelli-Fi networks continue to be ahead of the curve and beat intense competition in the area of wireless network security products?

After the first pitch for funding, Prashant also realized that interesting technology solutions conceived of the Entrepreneurs may not necessarily be of interest to the Venture Capitalists unless it is proven to be scalable and unique.

Prashant met Gopinath, also a graduate of one of the famous IITs at a conference at the Indian Institute of Science (IISc) in Bangalore, India. Gopinath was recruited to engineer security products that can be embedded into WiFi devices and networks to provide enterprise-level security. Using comprehensive packet analysis, algorithmic classification schemes and prediction methodologies and accurate location tracking, the team at Intelli-Fi built the most comprehensive enterprise protection solution that could prevent all types of wireless threats.

Currently, there are 1500+ plus private and public sector enterprise across all key geographies that use Intelli-Fi security product line to prevent rogue attacks on their WiFi networks and take timely action.

In 2012, the secure product line of Intelli-Fi was rated as one of the best WIPS compared with other products from firms such as Cisco, Aruba Networks, Fluke Networks and Motorola.

After security, it is the cloud

WiFi networks and devices have exponentially grown since then. According to WiFi Alliance, 3 billion WiFi devices are expected to ship in 2018, and the installed base is reaching 9.5 billion! The critical infrastructure in a WiFi network is the access point (AP). APs are networking devices that allow wireless WiFi devices to connect typically to a backhaul wired network. The backhaul wired network is normally connected to the Internet so that the WiFi devices are enabled Internet access. Due to the limited range of radio spectrum in WiFi networks,

many APs are required to provide coverage in a geographical area. The APs are installed within (1) private spaces such as enterprises, schools, universities and hospitals; (2) homes and (3) public spaces such as airports, restaurants (also referred to as public hotspots) and railway stations. A typical enterprise comprises of hundreds of APs connected to the enterprise networks to provide coverage across the firm. Number of public hotspots in the world is showing exponential increasing and is expected to reach about 350 million by 2018. It is predicted that there will be one public hotspot for every 20 persons on the earth (iPass, 2014).

Managing APs is a nightmare for any network department in an enterprise. APs need to be configured and managed for (1) coverage with good signal strength, (2) authentication using service set identifier definition (SSID) and associated password granting mechanisms, (3) down time due to power fluctuations and (4) intrusion protection for rouge attacks and so on. If the number of APs exceeds 4 or 5, then they can be grouped together and managed by access controller (AC). However, ACs are also deployed at the WiFi network location and hence to be monitored as well. Sometimes network engineers need to be sent to the site for inspection for fixing faults at odd hours. When users have difficulty in Internet connectivity, typically WiFi gets the blame. The IT staff spend on an average 50% of their time trouble shooting WiFi-related complaints. Hence, it is very important for the network managers to keep WiFi networks in good health with minimal down time.

Prashant recognized this as an opportunity. He and his team conceptualized a cloud-based architecture, wherein the management control of the APs is moved to the cloud service, instead of being deployed in local ACs. However, proprietary cloud-based WiFi management solutions were already available from Cisco and other networking vendors:

> How could Intelli-Fi make a mark and enter in to this competitive market?

Dr Joshi and his team realized that while the hardware of network elements are getting commoditized, and intelligent value added processing is shifting to software layers. In tune with this trend, Cumulus Networks started Open Network Install Environment (ONIE) in 2012. The ONIE (2017) is an open source initiative that defines an open 'install environment' for bare metal network switches. ONIE enables a bare metal network switch ecosystem, where end users have a choice among different network operating systems. This is very much beneficial for users, as they are not vendor locked. They can mix and match inter-working operating systems, hardware elements, network AP software, network controller, and management software from different vendors. Soon after its launch, many smaller vendors have started manufacturing minimal metal network switches including WiFi APs that are ONIE compatible. This created a window of opportunities for

software product companies such as Intelli-Fi networks to create layers of software suite for WiFi APs.

Intelli-Fi developed a 'cloud WiFi' platform, through which the ONIE-compatible APs can be controlled and managed. The cloud-based architecture makes it possible for user organizations to scale up their WiFi networks without adding expensive proprietary APs and technicians to trouble shoot at installation sites.

Since cloud controllers collect information from all network APs, these data can be mined and analysed using machine learning algorithms to automatically detect network anomalies, do root cause analysis and pinpoint solutions in real time. Leveraging the powerful and scalable computing capabilities of the cloud, Intelli-Fi also developed 'Smart WiFi' that monitors about 300 performance variables of APs and determines what is normal for each environment, draws baselines for the behaviour and highlights anomalies. Baselines are provided for critical WiFi factors such as client connectivity, poor performance, data rates, latency, and applications. Smart WiFi leverages intelligent APs and the power of the cloud to simplify, automate and provide insights into all aspects of WiFi operation, thus improving network performance, availability and reliability.

Intelli-Fi released the first version of its smart WiFi platform that embeds all the above in a single cloud platform in early 2016. With the pay-as-you-go model, the cloud-based management optimizes operational cost of maintaining large scale WiFi network deployment.

Today, about 2750+ customers subscribe to the smart WiFi cloud platform of Intelli-Fi:

> How can Intelli-Fi offer an integrated WiFi solution to the customer, including APs, cloud management and smart WiFi? How does it compare with other competing platforms offered by Cisco and HP Enterprise networks? Will it stand the test of time?

The third radio AP

Most modern WiFi devices are dual-band, meaning that they have two radios, one on 2.4 GHz, originally designed to support devices running older WiFi protocols like 802.11a/b/g and a more modern 5 GHz – 802.11ac running at higher speeds than 2.4 GHz. A few of the key benefits of using the 5 GHz band is that it occupies a channel that typically has less interference, is much less congested, and supports better speeds; while the 2.4 GHz band has better range but is more susceptible to outside interference. Further in 2009, IEEE standardized IEEE 802.11n that uses 'multiple input multiple output (MIMO)' to increase data speeds up to 600 Mbps. While the user demand for better performance and more throughput continued, Intelli-Fi developed a technique by which all the control and management functions such as spectrum scanning and intrusion prevention checking can be assigned dedicatedly to a third radio antenna. Dedicating the third radio to any of these functions leaves the other two radios free to deliver high-performance

WiFi access over 2.4 and 5 GHz to 802.11n, 802.11ac Wave 1 and Wave 2 clients.

In 2016, Intelli-Fi released its first WiFi AP with third radio that substantially improved the performance of APs, thus providing users with significantly better network experience:

However, at the same time, Cisco also released APs with third radio with similar functionalities:

> Can Intelli-Fi compete effectively with the large firms with their huge sales force and technical manpower in marketing its three radio APs? Will firms such as Netgear who also develop similar APs join hands with Intelli-Fi for its cloud based network management solutions to provide an integrated offering?

Proof is in the pudding

Prashant with his grit and determination was able to create Intelli-Fi with a vision to develop high-tech products from India for the global market. The dedicated team of about 250 engineers at Bangalore, India's centre of Intelli-Fi, continue to augment the product line, keeping up with technology and business trends. It has been a long and satisfying journey for the academician turned entrepreneur now that the firm that he created has close to 2800 customers deploying 500,000+ devices across the globe

Intelli-Fi raised over $46 million in funding, having raised its first Series-A round of funding of $10 million from early-stage venture capitals, way back in 2003. In 2017, Intelli-Fi raised $30 million in Series-E funding round. Revenue of Intelli-Fi touched about $50 million. Today, Intelli-Fi networks show a healthy trend with clients, including Time Warner Cable, Food and Drug Administration (FDA), Hilton, Overstock and ADP.

Although its main development team is located at Bangalore, India, Intelli-Fi shifted its headquarters to Mountain View, California, USA, to be nearer to the vibrant market for its product line. A veteran with 25 years of international experience was recruited to lead its operations as CEO. Prashant continued to be the CTO, guiding the technical efforts of Intelli-Fi.

Not to forget India

Intelli-Fi has been selling its products and services mainly to clients based in the United States. Opportunity knocked on its door in the form of a mobile operator that made a very late entry in the Indian mobile services market. This new entrant that participated in the spectrum auction held in 2010 in India, acquired nationwide licence and spectrum in 2300 MHz. After much delay, the operator rolled out its first fourth-generation long-term evolution (4G-LTE) network in the country in 2017. Being a later entrant, the operator had to leverage technology to provide better customer experience to acquire and retain subscribers to compete against well-entrenched incumbent telcos. WiFi penetration has been and is poor in India. One of the

main reasons is the lack of high capacity backhaul. However, the operator was one of the first telcos in India to consider WiFi as a serious option to improve broadband connectivity. The operator embarked on a massive deployment of WiFi networks in the country. Intelli-Fi was chosen as a preferred partner by the operator in its efforts to build WiFi hotspots in the country. In one of the first carrier WiFi deployment, Intelli-Fi deployed about 100,000 WiFi APs that are then managed by its cloud-based smart WiFi architecture. The operator was able to leverage the products of Intelli-Fi across the following primary use cases:

1. Hotspots at public locations for providing data connectivity to its travelling subscribers;
2. At colleges and educational Institutions, where there is a captive WiFi user base of students;
3. At select locations, especially at indoors for off-loading heavy traffic away from its 4G LTE network to WiFi to relieve the load on the cellular network.

Future beckons

The excitement around WiFi does not seem to end. With the development of IEEE 802.11ad that operates in the high-frequency 60 GHz spectrum, access speeds of up to 1 Gbps are possible. The WiFi alliance is also promoting fixed wireless local loop using IEEE 802.11ay, which gives emerging countries such as India to provide reliable last-mile access. World over, the V-band (i.e. 60 GHz band) has been delicensed for the proliferation of the above technologies.

There is a new thrust for setting up 5 million public WiFi hotspots by 2020 in the National Digital Communications Policy 2018 of India. All these provide huge opportunities for Intelli-Fi networks:

> Having grown to a successful firm deploying the cutting edge WiFi technologies, should Intelli-Fi and its founders look for exit? If so, is it an Initial Public Offering (IPO)? Or selling stakes to a larger networking company?

Suggested case questions

1. What should be the focus of tech entrepreneurs such as Dr Prashant Joshi while building products for a global market?
2. How is IT product development different from IT services?
3. Should a firm such as Intelli-Fi concentrate on products, services or both?
4. What are the characteristics of an entrepreneur that could lead to success in the venture? How do you see them manifesting in Dr Prashant Joshi?
5. What is the future of WiFi and related products?
6. What could be the augmentation to Intelli-Fi's smart cloud platform?
7. What could be the future of Intelli-Fi? Is it prone to acquisition?

Declaration of conflicting interests

Funding

Note

Dr Joshi is a pseudonym for the purposes of the case.

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References

Anderson C (2003) The Wi-Fi revolution. Available at: https://www.wired.com/2003/05/wifirevolution (accessed 11 May 2018).

iPass (2014) WiFi growth map. Available at: https://www.ipass.com/press-releases/ipass-wi-fi-growth-map-shows-one-public-hotspot-for-every-20-people-on-earth-by-2018/ (accessed 2 April 2019).

National Association for Software and Services Companies (NASSCOM) (2017) IT-BPM Industry in India: Sustaining growth and investing for the future.

Open Network Install Environment (ONIE) (2017) Available at: http://onie.org/(accessed 2 April 2019).

Prasad R and Sridhar V (2014) *The Dynamics of Spectrum Management: Legacy, Technology, and Economics*. Oxford: Oxford University Press.

Sridhar V and Vadivelu S (2011) *Challenges in Developing Products for an Advanced Mobile Market: Sasken's Experience* (Case Reference No: 09/459C). Lung Fu Shan, Hong Kong: Asia Case Research Centre, The University of Hong Kong.

The Economist (2004) A brief history of Wi-Fi. *The Economist*, 10 June. Available at: https://www.economist.com/node/2724397 (accessed 11 May 2018).

WiFi Alliance (2003) Securing Wi-Fi wireless networks with today's technologies. Available at: http://kambing.ui.ac.id/onnopurbo/library/library-ref-eng/ref-eng-3/physical/wireless/security/wp_4_Securing%20Wireless%20Networks_2-6-03.pdf (accessed 11 May 2018).

Author biography

Varadharajan Sridhar is the author of two books published by the Oxford University Press: *The Telecom Revolution in India: Technology, Regulation and Policy* (2012), and *The Dynamics of Spectrum Management: Legacy, Technology, and Economics* (2014). His third book titled *Emerging ICT Polices and Regulations: Roadmap to Digital Economies* is in process and expected to be completed in 2019 with Springer Nature Publications.