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Abstract Title: **Effect of New Technology on Diffusion: Case of India**

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Effect of New Technology on Diffusion: Case of India

Abstract: Technological changes in mobile technology have radically changed the people's life by increasing their ability to communicate. Providing enhanced voice capability, high speed data service, better spectrum management and coverage has resulted in different mobile technology generations in the market. India represents one of the fastest growing economies in mobile communication penetration with two competing technologies in 2G-the GSM and CDMA.

Thus the objective of this paper is to analyze the effect of new technology on the existing technology diffusion process. In this paper we consider mobile technological change in India. The Epidemic diffusion model depicting the S –curve is selected for the study. This work will help gain better understanding of diffusion process of mobile technologies and the learning can play an important role in developing diffusion strategy of future technologies like 3G.

Keywords: Diffusion, S-Curve, Technological change

Introduction

Technological changes in mobile technology have radically changed the people's life by increasing their ability to communicate. Invention, innovation and diffusion is a sequence in the whole technological change process (Schumpeter 1947; Stoneman 1995). The concept of diffusion here refers to the spreading of new technologies across potential markets and typically follows an S-curve. Both the rate of technological change and the speed of technological diffusion have increased significantly in recent years .The new technologies when appear broaden the market by making new applications feasible and economical. The main drivers for

the diffusion of mobile telecommunications have been technological progress that has allowed for relentless cost reduction and increase in performance. Providing enhanced voice capability, high speed data service, better spectrum management and coverage has resulted in different mobile technology generations. Digital (i.e. second-generation or 2G) mobile telephony was introduced in different technological flavors globally. It is divided into 2 major standards – the GSM and the CDMA. Of the different technological standards, the GSM (Global System for Mobile Communication) standard grew dominant and still enjoys over 80% market share worldwide. Different countries operated on different standards. European Union countries chose a single second generation wireless standard, GSM, while in other countries, like US, Canada, Korea and Japan various standards were competing.

Telecom is one of the fastest growing sectors in India. With GSM as an existing technology, CDMA mobile services were launched in December 2002 and in these seven years the Indian cellular market has seen major competition between it and GSM technology. It took several CDMA operators, device makers and technology facilitators to make India a well known CDMA enabled country and now has the world's second-largest CDMA market. The technological competition between the two has resulted in the improvement of services for the user. With the view to succeed in such a competitive environment new telecommunications service must meet some important criteria in order to achieve widespread acceptance: it must be cost-competitive; it must be compatible and, it must provide a relative advantage to the user. Different service providers have been launching various plans to attract customers but there is still a question as to which of the two technologies will lead eventually. The co-existence of these two technologies exerts an influence on each other diffusion process and will also affect overall diffusion of mobile technology, either positively or negatively.

In this paper we consider mobile technological change occurring in mobile service sector in India and analyze the effect of the new technology (CDMA) on the existing technology (GSM) diffusion process and study the diffusion relationships between these two communication technologies. The Epidemic diffusion model depicting the S –curve is selected for the study.

Overview of Mobile Technology in India

The Mobile telecommunications system in India is the second largest in the world and is divided between the two technologies GSM and CDMA. The mobile services were commercially launched in August 1995 in India with GSM as the technology. Since then the sector has undergone a major process of transformation because of significant Government policy and technological reforms. With the perspective to provide better voice and data quality and to target the vast potential in India, the new technology CDMA (Code Division Multiple Access) was launched in 2002 . The GSM sector is dominated by Airtel, Vodafone-Hutch, and Idea Cellular, while the CDMA sector is dominated by Reliance and Tata Indicom. CDMA is a "spread spectrum" technology, allowing many users to occupy the same time and frequency allocations in a given band/space. It assigns unique codes to each communication to differentiate it from others in the same spectrum. In a world of finite spectrum resources, it enables many more people to share the airwaves at the same time than do alternative technologies. The CDMA air interface is used in both 2G and 3G networks. 2G CDMA standards are branded cdmaOne and include IS-95A and IS-95B. The new technology gives a greater level of privacy and security to the communication and provides better data services. There are now more than 100 million CDMA subscribers in India, making it the world's second-largest CDMA market. Reliance Communications and Tata Teleservices are placed among the top five CDMA operators globally,

ranking second and fourth, respectively. This rapid growth of CDMA users in India is attributed to a wide selection of affordable devices - ranging from entry level handsets to feature-rich smart phones and their data services. Within one and half years after the introduction of CDMA tariffs drop by 42% thus making the service affordable to the masses and bridging the digital divide as shown in figure 1 .

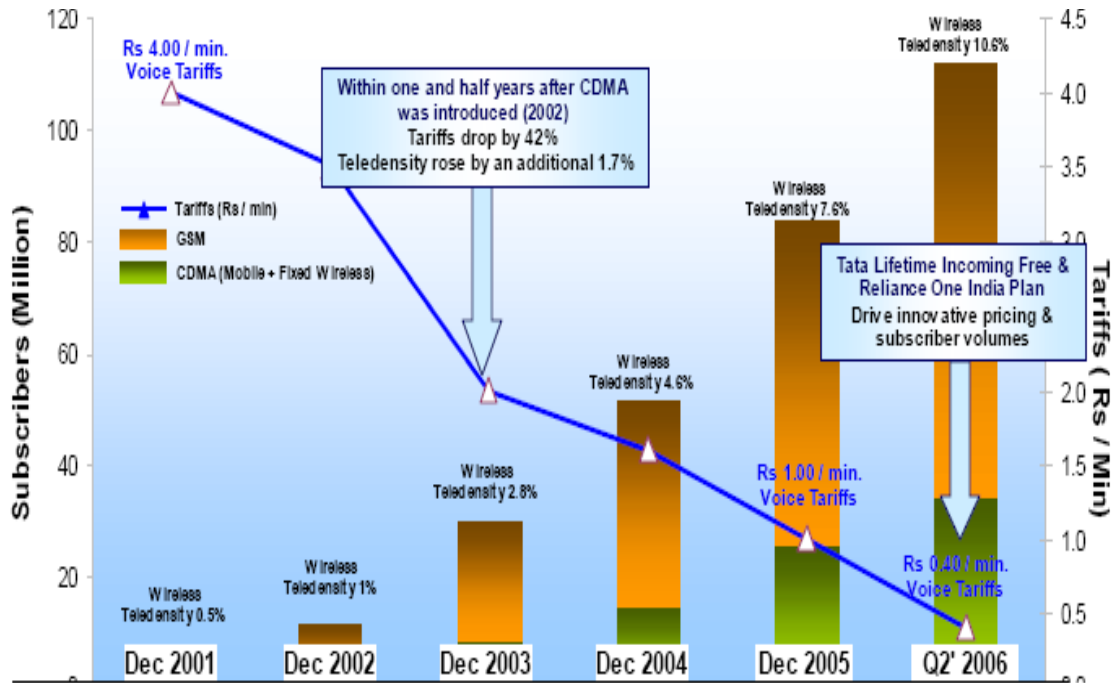


Figure1: Impact of CDMA (Sources: [1], [2], [3], [4])

The intensity of competition has increased in recent months following the launch of GSM services by Reliance Communications (RCom) and Tata DoCoMo, CDMA services by Sistema Shyam. Total Wireless (GSM + CDMA) subscriber base has increased to 471.73 Million at the end of Sep-09, and wireless Tele-density reached 40.31 .The Ratio of GSM to CDMA subscriber is as shown in figure 2.

[1] <http://www.cdg.org/>

[2] <http://www.auspi.in/>

[3] <http://www.coai.com/>

[4] Telecom Regulatory authority of India reports from 2004 - 2009

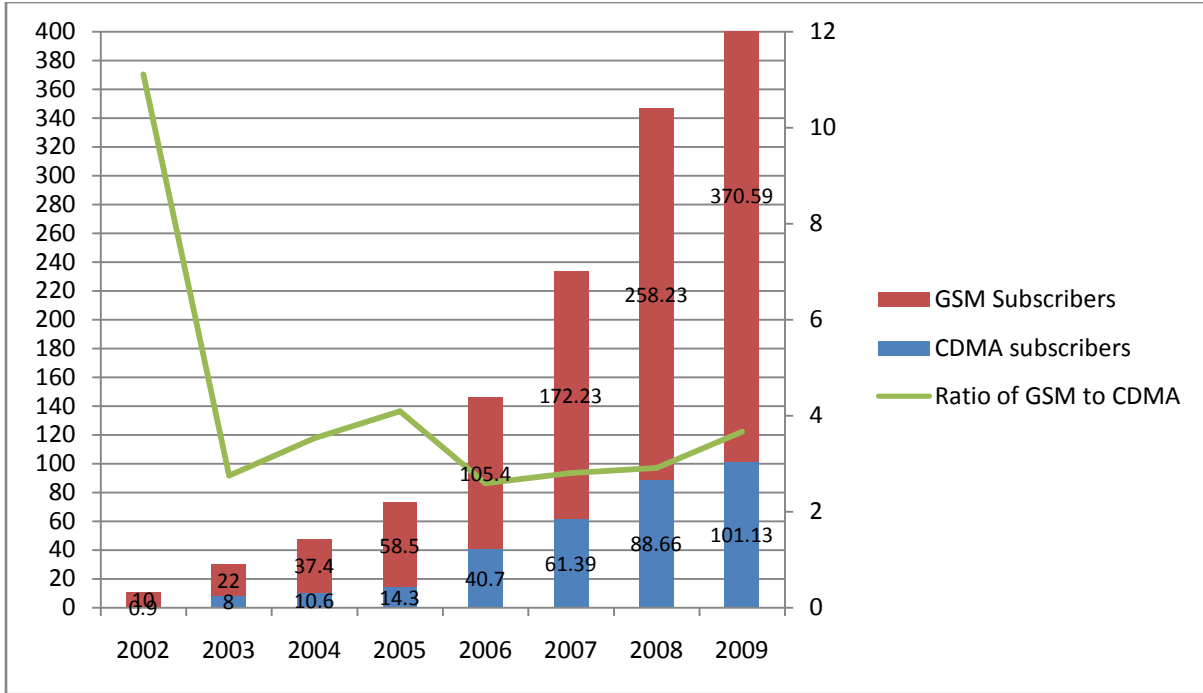


Figure 2: Wireless Subscriber growth in millions (Source: Performance Indicator Report 2004-2009(TRAII))

Diffusion Model for a Single Technology

It has been found that technology diffusion over time typically follows an S-curve. This S-curve can be modeled by various mathematical functions known as diffusion models. In this paper the epidemic diffusion model is used to analyze the diffusion of mobile technology due to its contagious nature of spread of technology information. The epidemic diffusion model can be classified into 3 categories-Bass, Logistic and Gompertz. Selection of the model is case dependent and model selection can be different for different technologies. The logistic and Gompertz diffusion model of single mobile technology can be formulated as follows:

$$\frac{dS_t}{dt} = bS_t \left(1 - \frac{S_t}{N} \right) \text{ ----- (1)}$$

$$\frac{dS_t}{dt} = b S_t (\ln N - \ln S_t) \text{ ----- (2)}$$

Where S_t denotes the number of subscribers at time t , b denotes success rate of technology diffusion (co-efficient of imitation), N denotes the saturation level. Rate of growth in the number of subscribers is positively influenced by the number of existing subscribers, as well as by the difference between the saturation level and the number of existing subscribers. It follows that the growth rate declines as the number of potential subscribers decreases. The term $(1 - \frac{S_t}{N_t})$ represents the negative feedback or retardation to growth of technology diffusion by itself.

Diffusion Model for Two competing technologies

For the case of India, there are two competing mobile technologies –the GSM and the CDMA providing a similar type of service to the users. Thus the co-existence of these two technologies will have influence on each other’s diffusion process. The influence of CDMA technology to GSM technology in diffusion is directly proportional to proportion of CDMA *subscriber’s* in the total of subscribers N , and influencing coefficient is u_{21} . Subtracting the new technology influence $u_{21} \frac{S_t}{N}$ in term $(1 - \frac{S_t}{N})$, the logistic diffusion model of two kinds of competing technologies can be formulated as-

$$\frac{dS_{t1}}{dt} = b_1 S_{t1} \left(1 - \frac{S_{t1}}{N} - u_{21} \frac{S_{t2}}{N} \right) \text{----- (3)}$$

$$\frac{dS_{t2}}{dt} = b_2 S_{t2} \left(1 - \frac{S_{t2}}{N} - u_{12} \frac{S_{t1}}{N} \right) \text{----- (4)}$$

If the influence of the new technology (CDMA) to the existing technology (GSM) is less than the retardation effect of the existing technology, i.e. $u_{21} < 1$, and the influence of the existing technology to the new technology is greater than the retardation effect of the new technology, i.e. $u_{12} > 1$, it proves that the existing technology owns the dominant superiority in diffusion process (Luo and Shen, 2004)

Empirical Analysis

The quarterly data on cumulative mobile telephone subscribers of two communication technologies -GSM and CDMA are collected for 6-year time period (2004 to 2009) from the annual and performance indicator reports of Telecom Regulatory authority of India (TRAI) and Department of telecommunication, Government of India.

It has been found that both the technologies (GSM and CDMA) fit the single technology logistic model well as depicted in figures 3(a) and 3(b) respectively.

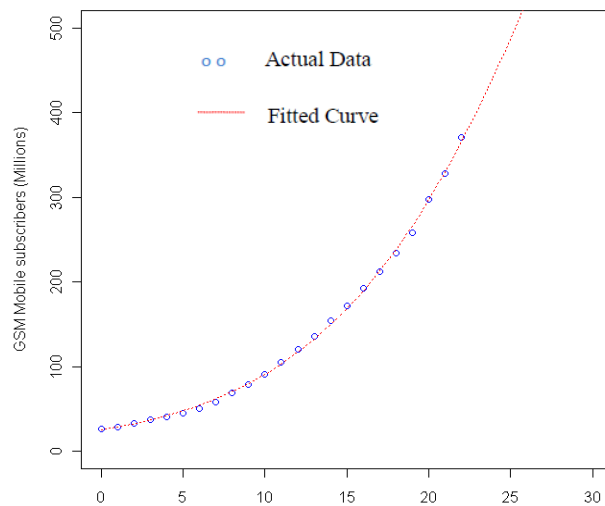


Figure 3(a) Logistic S-curve fitting for GSM

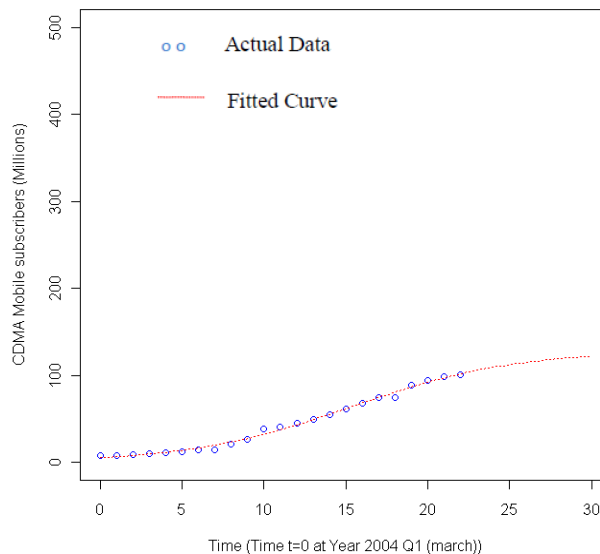


Figure 3(b) Logistic S-curve fitting for CDMA

Equations 3 and 4 of Logistic model for the two technologies were modified as equations 5 and 6. The total number of potential adopters of mobile technology i.e the saturation level is taken as estimated by Gupta and Jain (2010) for the logistic model. The multiple regression was applied to these set of equations using software PASW Statistics 18 to get the estimation results for the coefficients b_1 , b_2 and u_{21} , u_{12} which are as below.

FOR GSM

$$S_1(t + 1) - S_1(t) = b_1 S_{t1} \left(1 - \frac{S_{t1}}{N} - u_{21} \frac{S_{t2}}{N} \right) \text{-----(5)}$$

$$S_1(t + 1) - S_1(t) = 0.124 S_{t1} \left(1 - \frac{S_{t1}}{N} - (-2.862) \frac{S_{t2}}{N} \right)$$

FOR CDMA

$$S_2(t + 1) - S_2(t) = b_2 S_{t2} \left(1 - \frac{S_{t2}}{N} - u_{12} \frac{S_{t1}}{N} \right) \text{-----(6)}$$

$$S_2(t + 1) - S_2(t) = 0.194 S_{t2} \left(1 - \frac{S_{t2}}{N} - 1.432 \frac{S_{t1}}{N} \right)$$

From the analysis following conclusions can be drawn.

[1] The diffusion rate of CDMA mobile technology is faster than that of GSM, since imitation co-efficient of CDMA technology is 0.194 and that of GSM is 0.124. The CDMA reached 50 million subscribers growth milestone only in four years after the introduction to the market while it took GSM more than 10 years to reach the same number. The reasons could be

a) Technological Awareness- The existing GSM technology made the people aware about mobile technology and its common features which served as a readymade base for the CDMA technology.

b) Price Affordability- After the introduction of CDMA, bundling of services with ultra low cost handsets made the technology affordable to the masses thus offering relative advantage to the adopters. This price affordability information spread lead to faster

diffusion as compared to GSM technology, as the consumers of the technology in India are price sensitive.

c) Network Expansion-The other reason can be the Rapid expansion of the CDMA2000 networks into the untapped areas of India to deliver voice, rich data service and broadband Internet access.

[2] The value of u_{21} is -2.862 which indicates that the CDMA technology assists GSM technology by slowing down its (GSM) retardation process. The reasons could be

a) Intense Price competition

b) CDMA touched the pockets/areas where GSM has not reached by increasing the coverage capacity and making the potential users aware about the usage and advantages of the technology.

[3] The value of u_{12} is 1.432 which indicates that GSM technology assists the retardation process of the CDMA and thus GSM technology owns the dominant superiority in the diffusion process. The Retardation effect of CDMA can be attributed to the current limitations of the technology. One of the main reasons for GSM commanding the Indian telecom market over CDMA is that most of people in India tend to change or upgrade their handsets and CDMA limits this scope to some extent. The handset is locked to the service provider and limited choices are available. Once such kind of limitations is removed the CDMA may gain the momentum. Currently because of its incumbency nature, which gives it the first mover advantage, GSM continues to be the dominant technology till some major breakthrough appears.

Conclusions

In this paper technological changes and the diffusion of mobile technologies have been studied. Two mobile technologies, GSM and CDMA and their growth in India are discussed in detail. Different diffusion models for the single technology and the multiple technology model incorporating the influence of two technologies on each other is presented. This is one of the few studies done on mobile technology diffusion in India. The effect of CDMA technology on GSM diffusion process and vice versa is studied in Indian context. It has been found that the rate of diffusion of CDMA is faster as compared to GSM. CDMA made the mobile service economically feasible to the untapped masses. It is found that GSM technology owns the dominant superiority in the diffusion process. It can be concluded that in order to speed the diffusion of mobile technology continuous innovative ideas and customer friendly pricing strategies are required to remain competitive. The future work is being carried out for different technologies using different diffusion models.

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