



A New Model for Rural Mobile Coverage through Universal Service

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Abstract

Universal service was defined for basic wired services until the 21st century. As an emerging country, Turkey was also using universal service fund for this purpose. Turkey has also been expanding the mobile coverage during the last decade. There have been many projects to achieve this goal. The last one of such studies involves combining universal service with rural coverage. This new approach to universal service which is called “Universal Service Study for Mobile Coverage” is expected to bring coverage to the last 2128 locations that do not yet have GSM coverage. This paper explains the process up to now and ongoing Universal Service approach. The related data obtained from various sources is provided along with the model reflecting the determination of candidate locations for universal service coverage.

1. INTRODUCTION

The universal service is defined as the provision of basic telecommunications services to every citizen at an affordable price. The general definition was mainly about fixed-line telephony services until new services have arisen and the demand for services has shifted towards newly introduced services as substitutes of fixed-line telephony services. Because of this

reason, some European countries changed their stance against universal service obligations and started to apply these obligations for other services which are not defined in the Universal Service Directive (Directive 2002/22/EC).

Turkey also has a legal framework for universal service which is in line with the Directive. Apart from the Directive, Turkey has chosen to mostly use the Universal Service Fund as a resource to enhance the information technologies knowledge of the citizens rather than “offering basic services to every citizen at a reasonable price”.

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However, the importance of telecommunications and all-time available connectivity have increased and the effect of increasing telecommunications penetration as boosting economic growth, increasing productivity and reduce the differences between regions' development have become clear (Oğuz, 2013). In order to increase penetration, universal service is a good tool to increase the availability of a service throughout the country.

Since usage characteristics and preferences of customers have changed substantially in recent years, penetration of different telecommunications networks have changed rapidly. Penetration of mobile services has increased whereas the penetration for fixed-line telephone services decreased. Keeping this in mind, political perspective about universal service have changed from increasing fixed-line penetration to mobile penetration in Turkey. Because increasing mobile coverage is a better way to increase penetration in mobile services, Turkey has used the universal fund to enlarge the mobile coverage.

In this paper, a new perspective for using the universal service funds is offered. First the history and usage of universal service funds are depicted. Then some recent literature is examined which offer new studies in order to increase mobile coverage in rural areas. Then Turkey's approach to increase mobile coverage and using universal service fund for this purpose are explained. Last, a comparison is done between Turkish experience and recent literature.

1.1 Historical background for universal service

The Communications Act of 1934 of the United States defined the universal service as "making available, so far as possible, to all the people of the US, rapid, efficient, nationwide and worldwide wire and radio communication services with adequate facilities at reasonable prices" which is

considered the first modern definition of universal service (Madden, 2010). This definition was based on the assumption that all houses in the US should have a fixed line voice service which is offered at reasonable prices. At first, universal service served to interconnect different networks, not to offer basic services to each and every household (Mueller, 1997). The Telecommunications Act of 1996 has broadened the domain of the universal service and set the background for an independent universal service administration company.

European countries have a similar background. After the fixed-line companies have been liberalized, a universal service obligation has to be done. Universal service is defined as "the provision of a defined minimum set of services to all end-users at an affordable price" by European Commission in Universal Service Directive (Directive 2002/22/EC) which has set the legal framework for universal services. According to the Directive, the universal service is defined in fixed-line telephony services. These services include provision of access at a fixed location, directory enquiry services, public pay phones, reaching emergency call centers free of charge, and etc.

Although the universal services are defined for fixed-line telephony services in the Directive, change in offered services and access obligations drive for a change in both definition and application (Gideon & Gable, 2011). Penetration and usage of fixed-line services decline while mobile services are coming forward. For this reason, a new definition for universal service is needed and some countries in European Union (EU) has united fixed and mobile broadband markets as "broadband market" (Oğuz, 2013). Furthermore, there are several ways to access broadband internet such as cable, fixed-line and mobile, which cannot be separated clearly. Also fixed-line and mobile telephony services are considered as substitutes

(Oğuz, 2013). So, a new definition for universal service seems to be inevitable.

Most of customers are only concerned about the availability of some accessible service. Whether it is fixed or not, if there is broadband access, then the customers are satisfied and not concerned about the infrastructure or type of service. So, the fixed and mobile markets are converging depending on the needs and desires of the customers. Up to several years ago, universal service was only considered a liability for fixed-line telephony services but with the convergence effect, a new approach defining mobile operators and services as universal service incumbents and services is needed because of the satisfaction of the customers.

1.2 Mobile coverage

Governments, businesses, and other interested parties such as NGOs (non-government organizations) have taken various actions to bridge the digital divide, including creating community telecenters (Gamage & Halpin, 2007; Shariful & Nazmul, 2009), networked kiosks (Sattar, 2007), low-cost computing (James, 2003), local rural initiatives (Parker, 2000), and webpage building (Akca *et al.*, 2007). Some countries, particularly those in the Asia-Pacific region such as India (Rao, 2005), China (Xia, 2010; Xia & Lu, 2008), Korea (Park, 2002) and Japan (Wang, 1994), have made national plans. Initially, most of the efforts were devoted to increasing the level of connectivity in rural areas. With ubiquitous coverage gradually achieved and following further research on the social aspects of the digital divide, scholars have argued that the technology-centered approach was too simple and the focus should be shifted to a more comprehensive approach that addresses the basic social needs of rural communities (Park, 2008; Warren, 2007; Liu, 2012).

1.3 Rural coverage studies around the world

In India, most of the population (70%) lives in the villages which are small and approximately 42% of these villages do not have cellular coverage. In order to supply coverage to these villages, a gateway approach was offered (Gabale *et al.*, 2011). According to this approach, a gateway is built and coverage which is near to the village as 1 km is extended to the village by this gateway. The weak spot for this study is the need for coverage near the village.

Another approach (Heimerl & Brewer, 2010) offers a low power low capacity GSM base station called Village Base Station (VBTS) with long distance Wifi backhaul connection to the carrier. The advantage of this approach is allowance of free local voice and SMS services. It also needs less backhaul capacity since a small portion of all services is directed to the backhaul.

Another approach (Anand *et al.*, 2012) offers a low cost architecture called Village Cell as GSM cellular network using local rural-area network as backhaul connection. "Open BTS" serves as a small base station and all Open BTSs are located to ensure cellular connectivity throughout the village. As previous approach, all local communication including voice and SMS is free.

1.4 Mobile coverage and universal service usage in Turkey

1.4.1 Current situation

Turkey is a developing country of 780 thousand km² area and approximately 75.6 million population 2012 censuses (TUIK, 2012) and a population density of 98 persons/km². Nearly 75.2% of the population lives in cities with 10 thousand or more population. On the other hand, the number of residential areas with population of 1 thousand or less is 32540 which accommodates to only 12.3% of the total population. Currently, approximately 99%

of the total population has GSM coverage by at least one mobile operator (Fig. 1). The remaining 1% resides in 2128 residential areas which are populated less than 500. Since covering these areas is not economically viable for operators, bringing coverage to these areas is considered as a duty of the State. From another perspective;

increase in telecommunication penetration boosts economic growth, increases productivity and reduce the differences between regions' development levels. So, bringing coverage to these small residential areas will affect the overall economy of the country.



Figure 1: Population coverage map of Turkey

In Turkey, mobile services have started to be offered by mobile operators, Turkcell and Telsim, since 1994. However, first Concession Agreements were signed between the Ministry of Transport and mobile operators in 1998. As a result of these agreements, the operators received licenses for 25 years (until 2023). In 2000, two more licenses were granted to Is-Tim and Türk Telekom which used the brands Aria and Aycell, respectively. Aria was merged with Aycell to become Avea, in 2004. Based on the agreements, the coverage liability is defined for residential areas with 10 thousand or larger population. The biggest operator covers 99.17% of total population, while the second covers 99.05% as of September 2012.

All operators considered together, the coverage rises up to 99.65%, provided by more than 90 thousand base station sites all over Turkey. This rate is among the best coverage rates throughout Europe. Taking into consideration the difficulties such as landscapes, many small residential areas

and low population density in Turkey, it can be discussed that it is the best.

1.5 A new approach: rural coverage under universal service fund

Since the Concession Agreement states the coverage liability only for residential areas of 10 thousand or more population, smaller residential areas might have been uncovered according to the Agreement (Concession Agreement, 2005). Those areas form 24.8% of the population so it is important to offer coverage in these areas in order to both obtain a good coverage rate and offer service equally to all citizens.

In order to offer coverage in residential areas of less than 10 thousand population, Information and Communication Technologies Authority (ICTA) and Ministry of Transportation, Maritime Affairs and Communications worked with mobile operators. The coverage was defined as minimum signal strength of -104 dBm for 900 MHz, -102 dBm for 1800 MHz and -104 dBm for systems using both frequencies (Communique, 2012) with 75%

probability and included 4,026 residential areas between 1 thousand and 10 thousand population. The total population covered under this project is approximately 9.2 million which corresponds to 12.5% of

total population. As indicated in Figure 2 below, after the completion of this project, the coverage has risen to at least 90% of total population.

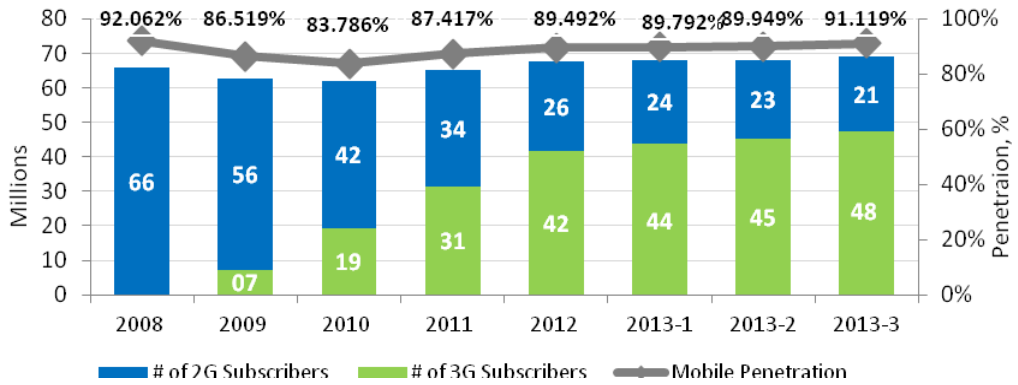


Figure 2: Mobile subscribers and penetration rate

Moreover, including the residential areas of population between 5 hundred and 1 thousand gained importance. 317 residential areas that were not covered by any operators were assigned to the 3 mobile operators as 135, 132 and 50. The minimum signal strength is also defined as -104 dBm with 75% probability to say that there is coverage. After this study, 317

locations are covered and it affected nearly 300 thousand people.

1.6 Efforts to enhance the coverage in Turkey

Using the data obtained from various sources, Table 1 and 2 reflect calculation of number of settlements needs to be included in the project.

Table 1: Description of variables and codes

Code	Variable
Tset	The number of total settlements in Turkey
Ts	The number of settlements with only Turkcell
Vs	The number of settlements with only Vodafone
As	The number of settlements with only Avea
TVs	The number of settlements with only Turkcell and Vodafone
TAs	The number of settlements with only Turkcell and Avea
Vas	The number of settlements with only Vodafone and Avea
TVAs	The number of settlements with all operators
Ys	The number of total settlements with an/some operator(s)
Xs	The number of settlements without any operators

$Tset = Ys + Xs$

$Ys = Ts + Vs + As + TVs + TAs + VAs + TVAs$

We need that the number of settlements without any operators (Xs).

$Xs = Tset - Ys$

The main sources of data used in this study are the database on mobile coverage of Turkey by ICTA and publicly available reports by Turkish Statistical Institute.

Table 2: The number of settlements by code

Code	Number of settlements	Sources
T_{set}	37084	Turkish statistical institute
T_s	1482	ICTA
V_s	1317	ICTA
A_s	378	ICTA
TV_s	4365	ICTA
TA_s	1084	ICTA
VA_s	625	ICTA
TVA_s	25705	ICTA

The Number of total settlements with a/some operator(s) (Y_s) can be calculated as follow;

$$Y_s = 1482 + 1317 + 378 + 4365 + 1084 + 625 + 25705 = 34956$$

$$X_s = 37084 - 34956 = 2128$$

Turkey has a new approach for universal service which will be on mobile network. Since all residential areas above 5 hundred populations are covered by at least one mobile operator, Ministry of Transportation, Maritime Affairs and Communications has decided to offer coverage by universal service at these locations. The aim is to increase the coverage to 100% throughout the country and thus, increase the penetration which will boost the economic growth and development state. For this purpose, Council of Ministers took action and issued a decision stating 2128 residential areas (Fig. 3) will be covered by mobile operators under Universal Service Fund. These 2128 locations were defined by ICTA according to the coverage. 2128 locations are not covered by any mobile operators with the signal strength of -104 dBm.

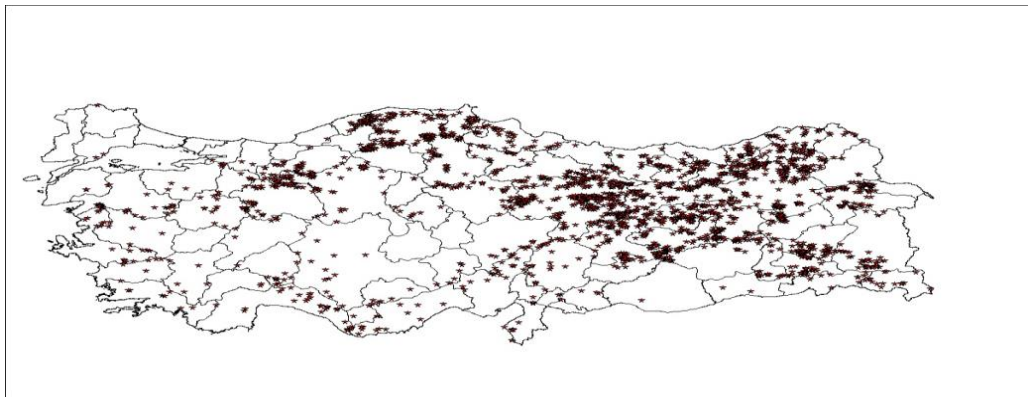


Figure 3: 2128 residential areas to be covered under universal service study

Turkcell submitted the lowest bid (TRY 312.77 million, excluding VAT) for a tender held by Turkey's Ministry of Transport, Maritime Affairs and Communications to provide mobile coverage to Turkey's 1,799 unsaved rural locations with a population lower than 500. The investment and the operating expenses will be disbursed from the universal service fund of the Ministry. The network infrastructure resulting from the tender will also be shared by other operators. The

tender process will be finalized after the evaluation of the tender commission.

Turkcell covers 99.17% of Turkey's population with about 32,500 base stations. When the work is completed, Turkey will be covered 100% by at least one operator and 315 thousand people living in these 2128 locations will experience GSM coverage.

The work consists of delivering GSM coverage to 2128 rural residential areas

which are populated less than 5 hundred. These locations need high CAPEX to be covered because most of them are located in distant locations; mountain tops, valleys, forests etc.

According to the work specifications one incumbent operator will build the infrastructure and all operators will be able to offer service using this infrastructure. The incumbent will build the infrastructure suitable for either national roaming or RAN sharing methods. The incumbent would be chosen by the Ministry by auctioning and the operator bidding the less would win the auction. The incumbent operator will be responsible for all maintenance and operation services. The infrastructure will be suitable for all technical requests such as

lawful interception from relevant institutions. The GSM coverage will be offered in all 2128 locations with -102 dBm outside with 95% coverage probability. Also roads connecting these locations will be covered with macro base stations. Quality of service criteria such as call block rate and call drop rate defined by ICTA for mobile services will also be applicable for these areas. The transmission infrastructure will be chosen by incumbent but satellite transmission will not exceed 35% of total site number. The incumbent accepts to take action under 48 hours for defects except compelling reasons. Also some polygons, provided by ICTA, should be covered with macro cells in order to provide wide area coverage including roads, intersections, etc.

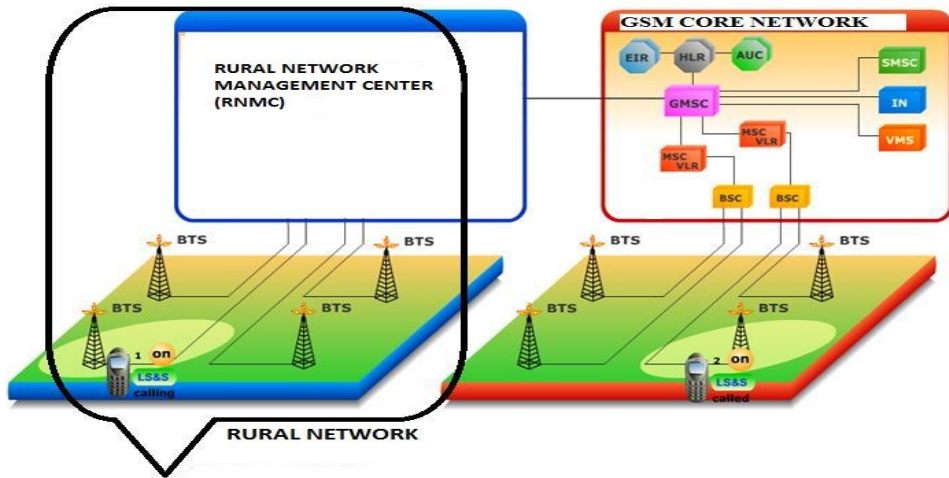


Figure 4: Rural GSM network infrastructure to be established

According to these specifications, the auction took place on 17.01.2013. The number of residential areas in the study dropped to 1799 since other 329 locations are covered (77-Avea Communication Services, 223-Turkcell Communication Services AŞ, 60-Vodafone Telecommunication, total 360, 29 location covered by 2 operators and 1 location by 3) during the preparation of study and Turkcell Communication Services won the auction with a bid of approximately 313 million Turkish Liras (excluding VAT). After the

inspection of bid and compliance with the specifications, the agreement was signed on 20.02.2013. Turkcell will build the infrastructure within 2 years and the infrastructure will be used by all 3 mobile operators by RAN sharing method.

The work is expected to be completed in 2015 and when it is over there will be great effects in telecommunications in Turkey.

- The population coverage for GSM services will reach 100% which means

all citizens will be able to use GSM service all over Turkey.

- GSM coverage is one of the key parameters determining the development level of a country. Since all of Turkey will be covered, overall development level of the country will rise. Also, people will be able to reach information technologies easier. Hence, level of knowledge of the country will increase.
- Last but probably the most important, 3 mobile operators will get together and build an infrastructure together in order to offer service at these locations. They will gain experience in acting together and this will be a good starting point for future works. Most probably, with the knowledge gained from Universal Service Study, 3 operators will work in LTE to build their infrastructure which will be beneficial for all parties and Turkey in general.

2. CONCLUSIONS

This research involves a case study about building mobile service infrastructure through a universal service fund at the locations without telecommunication infrastructures and evaluated as infeasible to invest at by the operators. Turkey is a big country with different land forms and low population density which makes it harder to increase GSM coverage. Despite

this fact, ICTA and Ministry of Transportation, Maritime Affairs and Communication worked together in many studies to increase the coverage. As a result of these studies, there only remains 2128 rural settlement areas which are populated less than 5 hundred not covered by any mobile operators. When the last study is completed in 2015, all residential areas will be covered, so overall coverage will reach 100 %.

This project will enable a solid infrastructure for the emerging new generation mobile communication such as 3G and 4G.

Mobile networks already cover over 99% of Turkey's population, but the remaining uncovered areas will receive financing from the universal service fund to ensure they are covered by mobile networks within three years. Turkey's universal service fund is financed from a variety of sources: 2% of the authorisation fees collected by the Telecom Authority; 1% of net revenues of all operators (except GSM); 10% of payments by GSM operators to the Treasury; 20% of administrative fines collected by the Telecom Authority; and, 20% of what remains in the budget of the Telecom Authority budget after all expenditures are deducted.

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