

# A study of Wireless Communications Systems based on Multiple Correspondence Analysis

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**ABSTRACT:** Today there are many wireless communication systems that meet the needs of users, however those systems remains a revolutions regarding the quality and security of service level. In this article, we discuss the comparison of the performance of various wireless communication systems such as WIFI, WIMAX, UMTS, HSDPA, GPRS, GSM, 3G and LTE using a multiple correspondence analysis (MCA) to classify and identify each system by their strong and weak mechanisms in terms of performance based on frequency band, rate, range, access technology, mobility, latency, modulation type and transmission type, in the aim to intended the characteristics that can increase the relevance and quality of the wireless communication system.

**Keywords:** IEEE 802.11g, IEEE 802.11e, IEEE 802.11m, GSM, GPRS, EDGE, UMTS, HSDPA, HSPA+, 3G, LTE, 4G, ACM

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## 1. Introduction

In recent years, several standards and wireless communication technologies have emerged and established themselves in our daily life, to such an extent that it is impossible today to imagine a world without applications or wireless services. These technologies have a role increasingly important in many aspects of our society and we can meet them everywhere: at home, office, outdoors, in transportation, etc [1]. The purpose of these technologies depends on not only communications, but also education, entertainment, navigation, health and trade.

Currently, several wireless standards and technologies exist and respond to specific needs and still in revolution, that is why this work is concerned with the study of the technical specification, in order to find the best among them, we concentrated in this article on the classification and sorting of these different systems based on multiple correspondence analysis which is detect the performance measure that increases the quality of the system, and this is the process of ACM method used.

### 1.1 Process Multiple Correspondence Analysis

In this context we schematized a process of method ACM for the catch of ranking by using software SPSS.

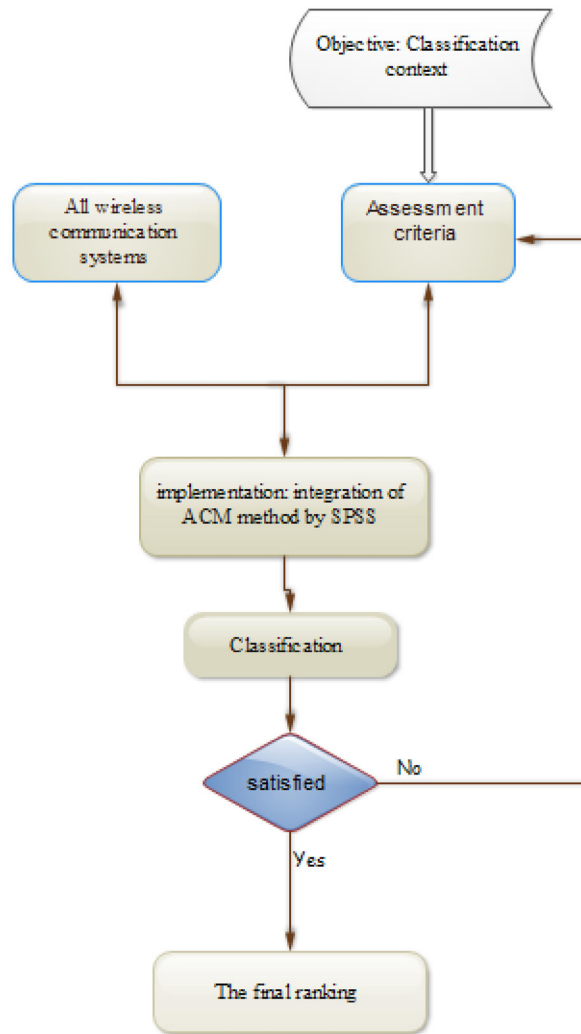


Figure 1. Process multiple correspondence analysis

## 2. Different Technique of Wireless Communications Systems and Criteria

### 2.1 Wireless Systems Communication

Wireless communication systems grow with time according to several criteria related to advanced technologies and science, taking into account the needs of users. [2]

Wireless Systems Communication are as follow:

- **WIFI** [3] [4]: Wireless Fidelity
- **WIMAX802.11g** [5]: Worldwide Interoperability for Microwave Access

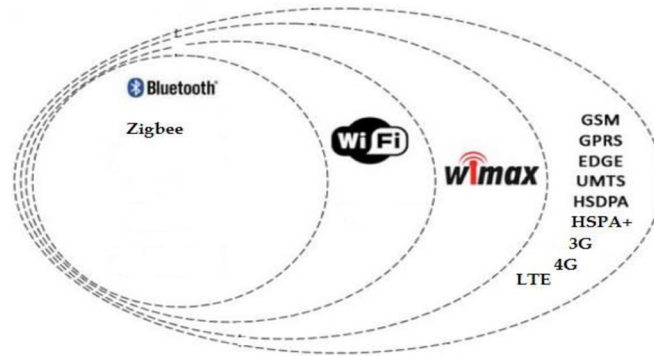


Figure 1. Wireless systems communication

- UMTS [6]: Universal Mobile Telecommunications System
- HSPDA [7]: *High Speed Downlink Packet Access*
- GPRS [8]: *General Packet Radio Service*
- GSM [9]: *Global System for Mobile*
- 3G [10]: *Third generation*
- LTE [11]: *Long Term Evolution*
- 4G [12]: *The fourth generation*
- EDGE [13]: *Enhanced Data Rates for GSM Evolution*
- HSPA+ [14]: *Evolved High-Speed Packet Access*
- WIMAX802.11m [15]: *Worldwide Interoperability for Microwave Access*

## 2.1 Different Characteristic

Wireless communication systems are characterized by:

- **Frequency Band (Mhz)[16]:** are groupings of radio frequencies that are used by mobile networks to communicate with mobile phones. The frequency bands that a phone supports determine to a large degree where and on which networks it can be used.
- **Range (Km) 17]:** Range or coverage is the geographic area where the station can communicate. Broadcasters and telecommunications companies frequently produce coverage maps to indicate to users the station's intended service area.
- **Throughputs (Mbits/s) [18]:** is a measure of how many units of information a system can process in a given amount of time. It is applied broadly to systems ranging from various aspects of computer and network systems to organizations.
- **Access Technology [19]:** Access methods are multiplexing techniques that provide communications services to multiple users in a single-bandwidth wired or wireless medium.
- **Mobility (Km/h) [20]:** is the capability of moving or being moved. The term is used in wireless telecommunications to indicate that a wireless device or a service may be used while moving.
- **Latency (ms) [21]:** is the delay from input into a system to desired outcome; the term is understood slightly differently in various contexts and latency issues vary from one system to another.
- **Modulation [22] :** is the addition of information (or the signal) to an electronic or optical carrier. Modulation can be applied to direct current (mainly by turning it on and off), to alternating current, and to optical signals.

• **Commutation [23]:** A synonym for switching in computer networking and telecommunications.

Wireless Systems Communication	Frequency Band	Range	Through puts	Acces Technology	Mobility	Latency	Modulation	Commu- tation
WIFI	2,4	0,1	54	CSMA	4,8	130	OFDMDSSS	Package
WIMAX802.11g	5,8	6,4	70	OFDMA	120	50	64QAMQPSKQAM16	Package
UMTS	2,1	10	2	CDMA	250	250	QPSK	Package
HSDPA	2,1	30	14.4	WCDMA	300	60	QPSK16QAM	Package
GPRS	1,8	10	0,14	CDMA	150	300	GMSK	Package
GSM	1,8	5	0,01	TDMA	150	300	GMSK	Package
3G	2,1	15	1,9	CDMA	200	100	8PSK	Circuit/ Package
LTE	2,6	30	326	OFDMA	350	100	64QAM16QAMQPSK	Package
4G	8	30	1000	OFDMA	350	50	64QAM16QAMQPSK	Package
EDGE	1,9	12	0,38	TDMA	200	300	8PSK	Package
HSPA+	0,01	7,4	14	CDMA	300	50	64QAM	Package
WIMAX802.11m	6	10	1000	OFDMA	350	30	64QAM16QAMQPSK	Package

Table 1. The Criterion of the Wireless Communication System

### 3. Comparative and Classification of Wireless Communications Systems Based on Multiple Correspondence Analysis

#### 3.1 Principle of ACM

Since we have several wireless communication systems and defined by different parameters, we chose to use the ACM method to classify each system through their powerful characters. And to get out the best among them in terms of criteria already specifiers.

In statistics, multiple correspondence analysis (MCA) is a data analysis technique for nominal categorical data, used to detect and represent underlying structures in a data set. It does this by representing data as points in a low-dimensional Euclidean space. The procedure thus appears to be the counterpart of principal component analysis for categorical data. [24] MCA can be viewed as an extension of simple correspondence analysis (CA) in that it is applicable to a large set of categorical variables.

#### 3.2 Application of ACM and Results

	Frequency Band (Mhz)	Range (Km)	Through puts (Mbits/s)	Access Technology	Mobility (Km/h)	Latency (ms)	Modu- lation	Commu- tation
Frequency Band (Mhz)	1000	,291	-,001	,357	,506	-,668	-,421	,030
Range (Km)	,291	1,000	-,629	,000	,628	-,358	,062	-,704
Debit theorique Mbits/s	-,001	-,629	1,000	,308	-,417	,246	,087	,398
Access Technology	,357	,000	,308	1,000	,371	-,439	-,489	,023

<b>Mobility (Km/h)</b>	,506	,628	-,417	,371	1,000	-,654	-,389	-,369
<b>Latency (ms)</b>	-,668	-,358	,246	-,439	-,654	1,000	,525	-,160
<b>Modulation</b>	-,421	,062	,087	-,489	-,389	,525	1,000	-,310
<b>Commutation</b>	,030	-,704	,398	,023	-,369	-,160	-,310	1,000
<b>Dimension</b>	1	2	3	4	5	6	7	8
<b>Valeur Propre</b>	3,247	2,296	,953	,660	,368	,244	,143	,089

Table 2. Correlations of the Transformed Variables

Those tables shown the correlation between the various criteria based on distance of chi-square, which measures the association between variables.

We noted that there is a strong association between the scope (Km) and mobility (km / h), and similarly for the scope in km and theoretical flow but with a strong association negative.

### 3.3 Table of Dimension

	<b>Dimension</b>	
	<b>1</b>	<b>2</b>
<b>Bande de frequence (ghz)</b>	,708	,325
<b>Range (Km)</b>	,676	-,657
<b>Throughputs (Mbits/s)</b>	-,453	,629
<b>Access Technology</b>	,474	,545
<b>Mobility (Km/h)</b>	,893	-,125
<b>Latency (ms)</b>	-,826	-,320
<b>Modulation</b>	-,542	-,580
<b>COMMUTATION</b>	-,291	,782

Table 3. Table of Dimension

According to this table we can see that the CMA gives us two factors, the first factor is highly positively correlated with the frequency bands (GHz) and mobility correlate strongly negatively km and with latency in ms, the second factor is correlated strongly - negatively with theoretical throughput Mbit / s and switching (see the graph below).

### 3.4 Principal Standardisation of the Variable

After the application of the MCA that aims to reduce the size of two factors, it is now conducting a classification technique on these two factors to build the class of Wireless Communications systems the more homogeneous, it is the hierarchical classification technique.

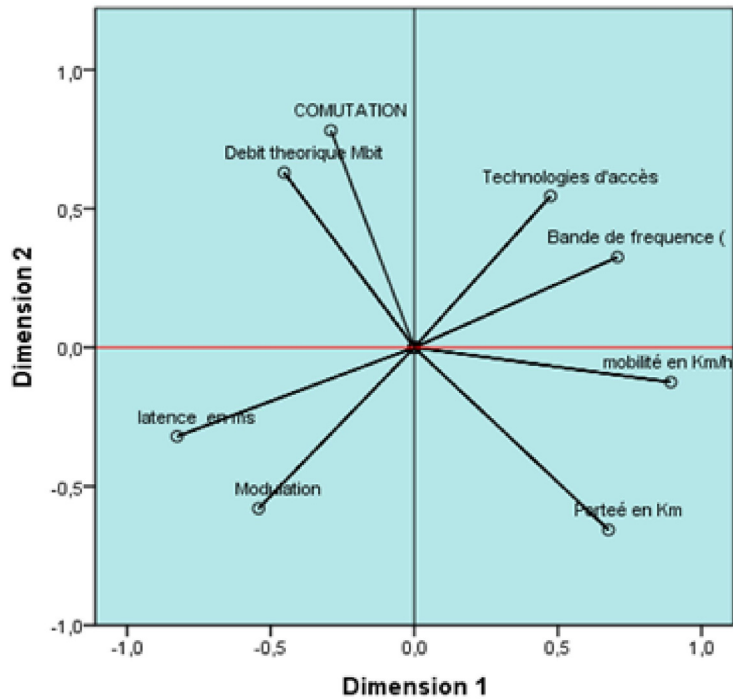


Figure 3. Principal standardisation of the variable

### 3.5 Hierarchical Clustering

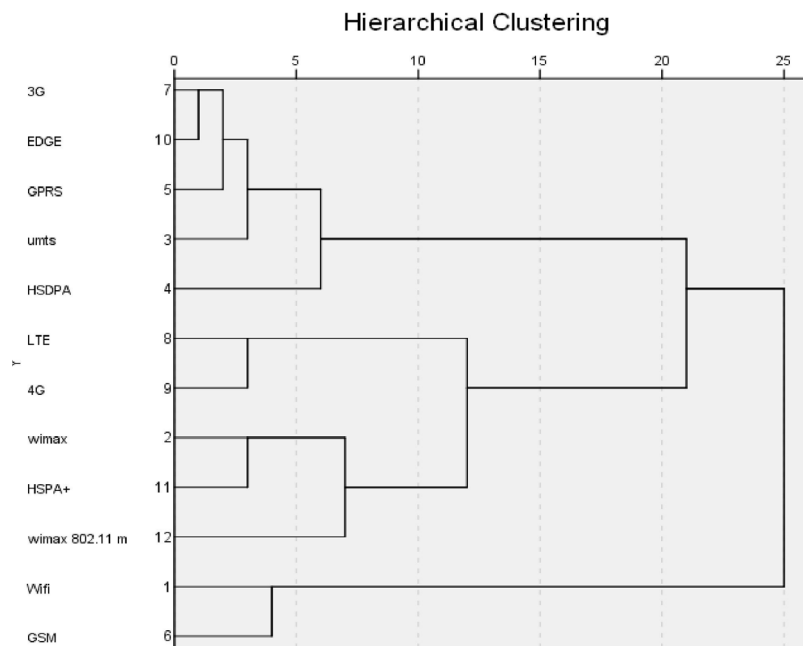


Figure 4. Hierarchical clustering

According to the hierarchical tree, we can create five classes (see fig): it is a factorial design where individuals are colored according to the classes, they belong (Fig):

So the classes obtained are:

Class①: GSM, WIFI

Class②: Wimax802.11g, HSPA+

Class③: 3G, EDGE, UMTS, GPRS, HSDPA

Class④: LTE, 4G

Class⑤: Wimax802.11m

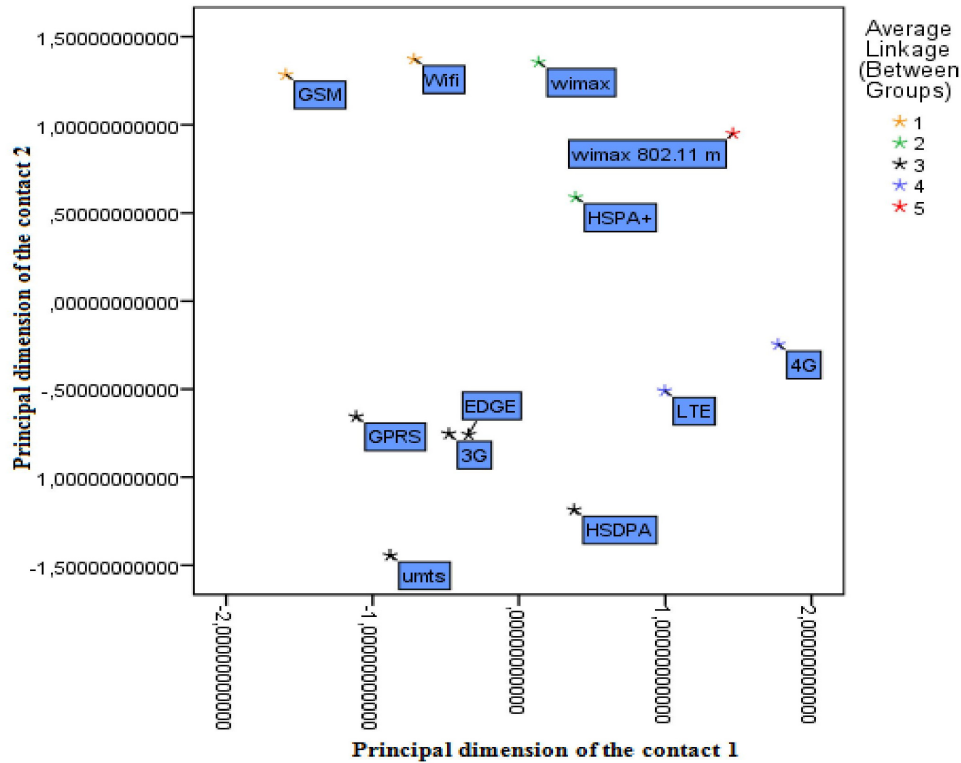


Figure 5. Double diagram

from the classes found we noted that:

- **Class 1:** Is characterized by the same switching and same theoretical throughput.
- **Class 2:** Is characterized by a medium frequency band and same access technology.
- **Class 3:** Characterized by a medium range and a significant lag.
- **Class 4:** Is characterized by better mobility and increased average theoretical speed and frequency band and low latency.
- **Class 5:** Is characterized by a strong band better mobility frequency, door and very low latency.

Therefore, we conclude that technical wimax802.11m, LTE, 4G Class 4 and 5 are the most efficient technology among wireless system we proposed, which means that for assessing the performance of a communication system wireless we just need to evaluate the criterion of mobility the frequency band, scope, latency.

#### 4. Conclusions

In this document, we presented wireless communication systems with their different performance characteristics. Compared with the multiple correspondence analysis, in fact the application of this method has confirmed that the selected wireless communication system and classified according to preference, the ACM method allows us to have the same result compared classical and theoretical methods.

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