



# ARCHES

H2020 – 693229

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## Deliverable D4.1 “Report on system requirements for handheld devices”

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**Abstract**

This report gives an insight into the requirements that need to be considered in the development of the mobile applications within ARCHES. In this report the characteristics, features and functionalities of the most popular handheld devices are summarised and compared. This includes information focused on people with difficulties associated with perception, memory, cognition and communication. This document will serve as reference to define the overall strategy regarding the implementations for smartphones and tablets. The planned general app as well as specific apps and serious games will build upon these requirements to ensure compatibility and a smooth user experience.

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## Executive summary

The objective of this document is to summarise and compare the characteristics, features and functionalities of the most popular handheld devices as well as the devices which are most favourable for people with difficulties associated with perception, memory, cognition and communication. Additionally, part of the participating museums were asked to provide the specifications and details of their currently used devices, in order to establish also their requirements for the apps being developed. Also, an individual target group with a high level of needs (deaf persons) was surveyed to identify the devices they used and the main reasons for choosing them.

A large overlap between the specific devices used by the museums as well as target audiences was discovered, which proves to be a strong benefit for ARCHES. The apps being developed will therefore be made available for the most popular devices and will be fully compatible with the devices used by the museums and the target audiences.

The main part of the document is structured as follows:

- Section 1 shows a brief introduction of the deliverable, our methodology and an insight to the planned components of the apps.
- In Section 2 the research data on handheld devices is presented.
- Section 3 closes the document presenting the conclusions of the deliverable, hence derives the “system requirements baseline for handheld devices”.

The document concludes with giving specific insights on what requirements are present from the perspective of the hardware and the operating systems of handheld devices. Besides giving guidance during the development process, this report can also be used to select the best possible test devices to ensure the quality of the apps.

## Document Information

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<b>Abstract (for dissemination)</b>	This report gives an insight into the requirements that need to be considered in the development of the mobile applications within ARCHES. In this report the characteristics, features and functionalities of the most popular handheld devices are summarised and compared. This includes information focused on people with difficulties associated with perception, memory, cognition and communication. This document will serve as reference to define the overall strategy regarding the implementations for smartphones and tablets. The planned general app as well as specific apps and serious games will build upon these requirements to ensure compatibility and a smooth user experience.
<b>Keywords</b>	System requirements, applications, functionalities, accessibility, handheld devices.

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## Abbreviations

**API:** Application Programming Interface

**AR:** Augmented Reality

**ARCHES:** Accessible Resources for Cultural Heritage EcoSystems

**EU:** European Union

**FLG:** Lázaro Galdiano Museum

**H2020:** Horizon 2020

**ICT:** Information and Communication Technologies

**MBBAA:** Fine Arts Museum of Asturias

**NGO:** Non-Governmental Organisation

**Thyssen:** Thyssen-Bornemisza Museum

**V&A:** Victoria & Albert Museum

**WC:** The Wallace Collection

**W3C:** World Wide Web Consortium

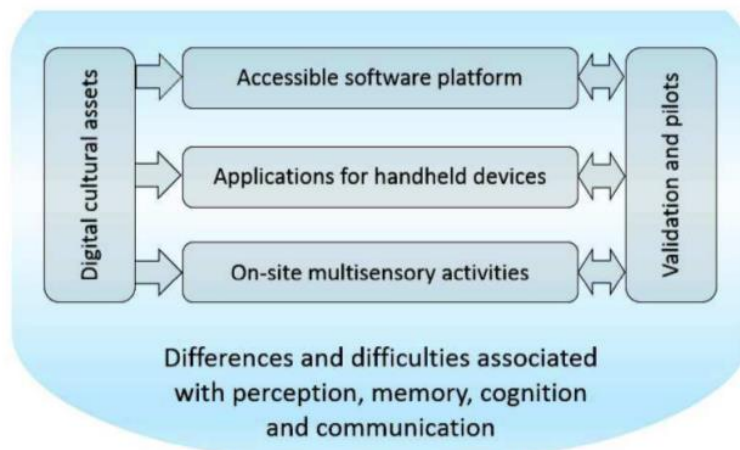


# 1 Introduction

The objective of this document is to summarise and compare the characteristics, features and functionalities of the most popular handheld devices. It will serve as reference (system requirements baseline) to define the overall strategy regarding the implementations for smartphones and tablets.

## 1.1 Methodology

Applications for handheld devices are an integral part of the overall approach of ARCHES as part of the overall methodology presented in Figure 1.



**Figure 1: Scheme of the overall approach.**

The aim is to develop applications for handheld devices that will allow people with differences and difficulties associated with perception, memory, cognition and communication to enjoy their visit to museums – on their own or with other people – thanks to the functionalities that take advantage of Augmented Reality (AR) and real-time processing techniques. Two alternatives will be developed: (i) a basic version ready to be used at any museum and (ii) an extended version in which extra functionalities are incorporated, resulting from close collaboration between the designers and the cultural heritage sites, sharing knowledge of the collection, the facilities and the nature of the digital assets. (See ARCHES deliverable D3.1 “Report on system architecture definition”).

The research contributed in this report provides an important step in the development process to ensure that all the applications and prototypes work properly and achieve the desired performance. Therefore, first general market data on the usage of smartphones is collected and put into a matrix. Secondly, data for people with differences and difficulties associated with perception, memory, cognition and communication is considered to adapt the matrix to the project target. Lastly, individual research for specific target audiences (e.g. deaf persons) as well as data from the participating museums is compared to the general matrix.

Thus, the most common characteristics and features are derived and included into the system requirements baseline for the applications for handheld devices.

While this report can give some limitations and fixed requirements for the development process, an intense test battery is planned to ensure that the applications also run on then state of the art devices. Most importantly, the stability and compatibility of applications will be assessed during the validation and pilot phases.

As described in ARCHES deliverable D3.1, we propose an iterative model in which a great deal of interaction is expected between the designers and the users. This will allow all partners to duly agree modifications, adaptations or improvements of the applications based on the feedback from the people with differences

and difficulties associated with perception, memory, cognition and communication, leading to more appropriate and effective results. Therefore the same scheme in Figure 2 is adopted in this context too.

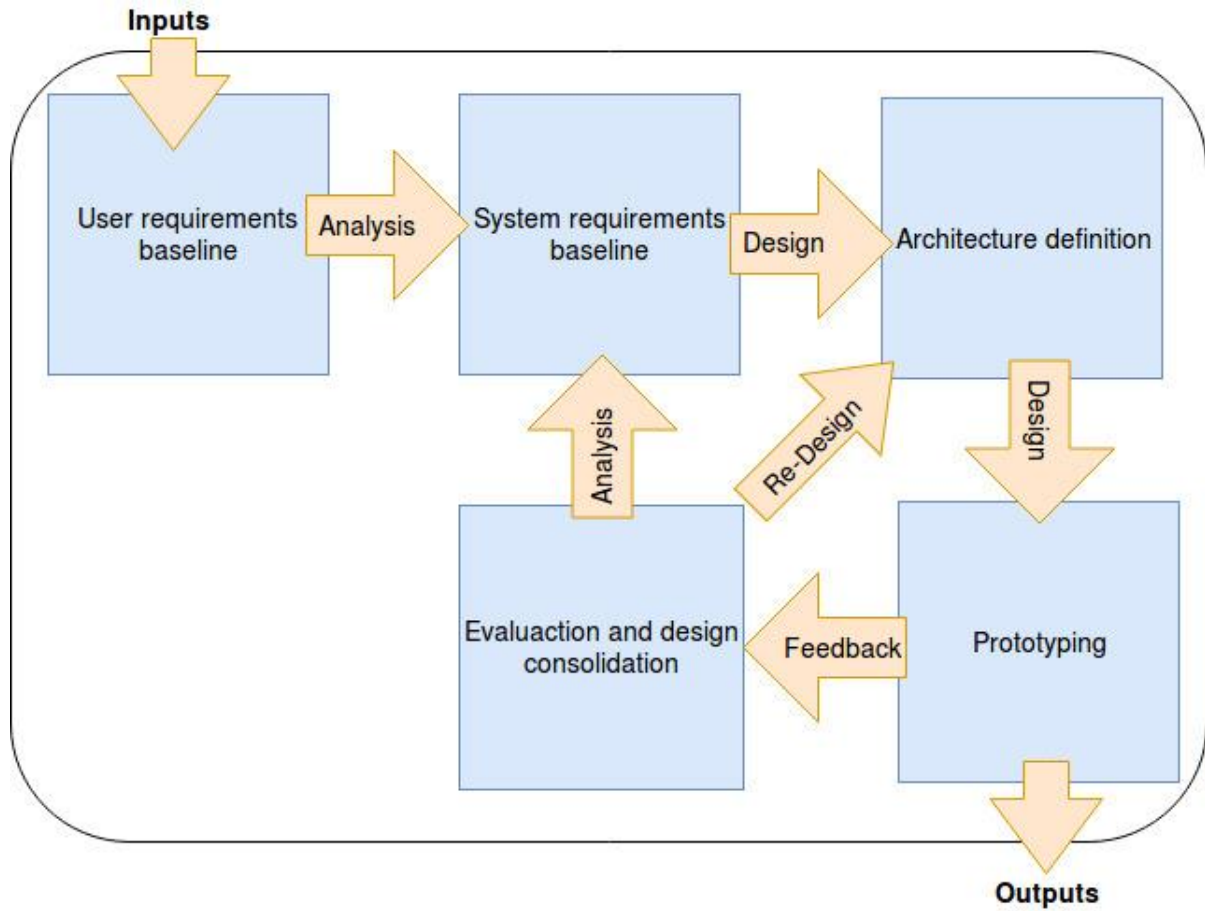


Figure 2: Architecture and design process.

## 2 Research data

### 2.1 General research on popular devices and their capabilities

#### 2.1.1 Market shares of smartphones and tablet companies and operating systems

In a first step, the market shares of smartphone and tablet companies were examined in order to generate a focus on which handheld devices should be taken into account.

According to Gartner as well as Statista, in both the smartphone and tablet markets, the companies of Apple and Samsung dominate the market globally. In the smartphone global market in 2016, Apple and Samsung were trailed by Hauwei, Oppo, Vivo, ZTE, LG, Xiami, Lenovo and TCL-Alcatel. At the end of 2016, Samsung came out on top of the global market controlling around 20.8% of the global market share while their closest competitor (Apple) controlled 14.5% of the market shares. The 4<sup>th</sup> Quarter of 2016 was the closest in history with Apple controlling 17.9% and Samsung controlling 17.8% of the market shares. These two companies heavily dominate the market with the next company in competition (Huawei) controls only 9.4% and all the other top 10 companies control less than 7% of the market shares. This information is summarised in Table 1.

**Table 1: Market Shares of Smartphone producers between 2015 Q4 to 2016 Q4**

PERIOD	SAMSUNG	APPLE	HUAWEI	OPPO	VIVO	OTHERS
2015 Q4	20.4%	18.7%	8.2%	3.6%	3.0%	46.2%
2016 Q1	23.7%	15.4%	8.4%	5.9%	4.4%	42.2%
2016 Q2	22.8%	11.7%	9.3%	6.6%	4.8%	44.9%
2016 Q3	21%	12.5%	9.3%	7.1%	5.9%	44.2%
2016 Q4	17.8%	17.9%	9.5%	6.2%	N/A	48.7%

The operating systems for smartphones runs along the same trends as the smartphone companies. With the top 4 operating systems are Android, iOS, Windows, and Blackberry. In comparison between the 4<sup>th</sup> Quarter of 2015 and 2016, both Android and iOS operating systems increased units sold and their market shares. Android selling 325,394.4 units with an 80.7% market share in 2015, and 352,669.9 units with a market share of 81.7% in 2016. IOS is coming in second, selling 71,525.9 units with a 17.7% market share in 2015, and selling 77,038.9 units with a 17.9% market share in 2016's 4<sup>th</sup> quarter. In a comparison, Windows and BlackBerrys unit sales and market shares decreased between the 4<sup>th</sup> Quarter of 2015 and 2016 as pointed out in Table 2. (unit sales in thousands)

**Table 2: Smartphone Operating System comparison between 2015 Q4 and 2016 Q4.**

OPERATING SYSTEM	2016 Q4 UNITS	2016 Q4 MARKET SHARE	2015 Q4 UNITS	2015 Q4 MARKET SHARE
ANDROID	352,669.9	81.7%	325,394.4	80.7%
IOS	77,038.9	17.9	71,525.9	17.7%
WINDOWS	1,092.2	.03%	4,395.0	1.1%
BLACKBERRY	207.9	0.0 %	906.9	.2%

Worldwide the smartphone market grew 1.1% from 2015 Q3 to 2016 Q3, with 363.2 million shipments (see Table 3). Although Samsung had to recall the Galaxy Note 7, they still retained their spot as their number 1 spot in the world. This is because of the continued success of the Galaxy S7 and the S7 Edge phones. Samsung has streamlined their portfolio of devices, including the affordable J-series, proved successful in many mid-tier markets that were typically dominated by local brands.

Although Apple shipped a total of 45.5 million units, which is a 5.3% decline from Q3 of 2015 to Q3 of 2016, the new iPhone SE did well in both emerging developed markets. The iPhone 6S and iPhone 7, were their number 1 and 2 selling devices.

**Table 3: Full year smartphone sales statistics 2014-2016.**

RANK	BRAND	2016 UNITS	SHARE	2015 UNITS	SHARE	2014 UNITS	SHARE
1	Samsung	308.9 M	20.8%	322.0M	22.4%	314.2M	24.2%
2	Apple	215.4M	14.5%	231.4M	16.1	192.7M	14.8%
3	Huawei	139.0M	9.4%	108.0M	7.5%	75.0M	5.8%
4	Oppo	91.0M	6.1%	50.0M	3.5%	---	---
5	Vivo	73.0M	4.9%	---	---	---	---
6	ZTE	57.0M	3.8%	57.2M	4%	46,1M	3.5%
7	LG	55.1M	3.7%	59.7M	4.2%	59.1M	4.5%
8	Xiaomi	54.3M	3.7%	71.0M	4.9%	61.1M	4.7%
9	Lenovo	53.1M	3.6%	76.3M	5.3%	95.2M	7.3%
10	TCL-Alcatel	38.0M	2.6%	43.5M	3.2%	41.4M	3.2%
<b>OTHER</b>		395.5M	26.8%				

In the tablet market (see Table 4), the top 5 tablet companies speaking in market share comparisons are Apple, Samsung, Lenovo, Huawei, and Amazon. In the 4th Quarter of 2016, the market share distributions were as follows Apple (24.7%), Samsung (15.1%), Lenovo (7%), Huawei (6%), Amazon (9.7%). Overall the top 5 companies market shares all increased between Q4 of 2015 to Q4 of 2016 with Apple increasing .4%, Samsung increase 1.5%, Lenovo increasing 2.1%, Huawei increasing 2.6%, and Amazon increasing 1.9%.

Nearly 270 million tablets are expected to be shipped worldwide by 2019. Europe has been a leader in the global market since 2013, when the region held about 28 percent of the global market. Shipments in the Asia Pacific region are projected to increase at a rapid pace, eventually passing Europe in number.

Although Apple has dominated the tablet market since 2011, they have slowly been decreasing their market share mostly with because of the emergence of new tablet companies/products. The market shares of the iOS operating system although has in the past been leading the market but has slowly been decreasing the market with the increased use of Android and other operating systems.

**Table 4: Market shares of tablet producers between 2015 Q4 to 2016 Q4.**

BRAND	Q4 2015	Q1 2016	Q2 2016	Q3 2016	Q4 2016
<b>APPLE</b>	24.3%	25.9%	25.8%	21.5%	24.7%
<b>SAMSUNG</b>	13.6%	15.2%	15.6%	15.1%	15.1%

<b>LENOVO</b>	4.9%	5.5%	6.6%	6.3%	7%
<b>HUAWEI</b>	3.4%	5.1%	5.6%	5.6%	6%
<b>AMAZON</b>	7.8%	5.6%	4%	7.3%	9.7%
<b>OTHERS</b>	46%	42.7%	42.4%	44.2%	37.4%

To conclude, the worldwide market research data clearly paints the picture of few dominant players in the handheld device market. As a result, mostly Apple, Samsung devices should be investigated to derive the system requirements.

### 2.1.2 Most popular smartphones and their features

In a second step, the most popular phones in Europe (per Insider Monkey) and as a comparison also the USA (per Device Atlas) were identified and compared from a technical perspective (see Table 5, Table 6 and Table 7). As expected from the general market share data, the most popular phones in Europe 2016 are Samsung Galaxy S6/Edge, iPhone 6, LG G4, Samsung Galaxy S5, Samsung Galaxy Note 4 Edge, iPhone 6+, HTC One M9, LG G3, Nokia Lumia 930, Sony Xperia Z3. The most popular devices in the USA 2016 were iPhone 6, iPhone 5S, iPhone 6+, Samsung Galaxy S5. Using Gsmarena.com and the specific websites of the smartphone producers a comparison table was set up in order to derive a fixed set of requirements that is prominent over all devices.

**Table 5: Comparison of most popular smartphone devices in Europe (I).**

	OS	DIMENSIONS	REAR CAMERA	FRONT CAMERA	CAMERA FEATURES	DISPLAY
<b>SAMSUNG GALAXY S6/EDGE</b>	Android OS, v5.0.2 to v7.0	70.5 x 143.4 x 6.8 mm (138 g)	16MP, f/1.9, 28mm, OIS, autofocus, LED flash	5MP, 1/4.1" sensor size, 1.34 µm pixel size, f/1.9, 22mm	1/2.6" sensor size, 1.12 µm pixel size, geo-tagging, touch focus, face detection, Auto HDR, panorama	5.1" Quad HD Super AMOLED, capacitive touchscreen, 16M colours
<b>IPHONE 6</b>	iOS 8 to iOS 10.3	138.1 x 67 x 6.9 mm (129 g)	8 MP, f/2.2, 29mm, phase detection autofocus, dual-LED (dual tone) flash,	1.2 MP, f/2.2, 31mm, 720p@30fps face detection, HDR, FaceTime over Wi-Fi or Cellular	1/3" sensor size, 1.5 µm pixel size, touch focus, geo-tagging, face/smile detection, HDR (photo/panorama)	4.7" LED-backlit IPS LCD, capacitive touchscreen, 16M colours, Ion-strengthened glass, oleophobic coating
<b>LG G4</b>	Android v5.1.1 to v6.0	148.9 x 76.1 x 6.3 - 9.8 mm (155 g)	16 MP, f/1.8, 28 mm, laser autofocus, OIS (3-axis), LED flash	8 MP, f/2.0, 1/4" sensor size, 1.12 µm pixel size, 1080p	1/2.6" sensor size, 1.12 µm pixel size, geo-tagging, touch focus, face/smile detection, panorama, HDR	5.5" IPS LCD capacitive touchscreen, 16M colours
<b>SAMSUNG GALAXY S5</b>	Android OS, v4.4.2 to v6.0	142 x 72.5 x 8.1 mm (145 g)	16 MP, f/2.2, 31mm, phase detection autofocus, LED flash	2 MP, f/2.4, 22mm, 1080p@30fps, dual video call	1/2.6" sensor size, 1.12 µm pixel size, geo-tagging, touch focus, face/smile detection, panorama, HDR	5.1" Super AMOLED capacitive touchscreen, 16M colours
<b>SAMSUNG GALAXY NOTE 4/EDGE</b>	Android OS, v4.4.4 to v6.0.1	153.5 x 78.6 x 8.5 mm (176 g)	16 MP, f/2.2, 31mm, OIS, autofocus, LED flash	3.7 MP, f/1.9, 22mm, 1440p@30fps, 1080p (HDR)	1/2.6" sensor size, 1.12 µm pixel size, geo-tagging, touch focus, face/smile detection, panorama, HDR	5.7" Super AMOLED capacitive touchscreen, 16M colours

	OS	DIMENSIONS	REAR CAMERA	FRONT CAMERA	CAMERA FEATURES	DISPLAY
<b>IPHONE 6+</b>	iOS 8 to iOS 10.3	158.1 x 77.8 x 7.1 mm (172 g)	8 MP, f/2.2, 29mm, phase detection autofocus, OIS, dual-LED (dual tone) flash	1.2 MP, f/2.2, 31mm, 720p@30fps, face detection, HDR, FaceTime over Wi-Fi or Cellular	1/3" sensor size, 1.5 µm pixel size, touch focus, geo-tagging, face/smile detection, HDR (photo/panorama)	5.5" LED-backlit IPS LCD, capacitive touchscreen, 16M colours
<b>HTC ONE M9</b>	Android OS, v5.0 to v7.0	144.6 x 69.7 x 9.6 mm (157 g)	20 MP, f/2.2, 28mm, autofocus dual-LED (dual tone) flash	4 MP, f/2.0, 27mm, 1/3" sensor size, 2µm pixel size, 1080p@30fps, HDR	1/2.4" sensor size, 1.2 µm pixel size, geo-tagging, touch focus, face/smile detection, HDR, panorama	5" Super LCD3 capacitive touchscreen, 16M colours
<b>LG G3</b>	Android OS, v4.4.2 to v6.0	146.3 x 74.6 x 8.9 mm (149 g)	13 MP, f/2.4, 29mm, phase detection/laser autofocus OIS, dual-LED (dual tone) flash	2.1 MP, f/2.0, 1080p@30fps	1/3" sensor size, 1.12 µm pixel size, geo-tagging, touch focus, face/smile detection, panorama, HDR	5.5" True HD-IPS + LCD capacitive touchscreen, 16M colours
<b>NOKIA LUMIA 930</b>	Microsoft Windows Phone 8.1 to 10	137 x 71 x 9.8 mm (167 g)	20 MP, f/2.4, 26mm, Carl Zeiss optics, OIS, autofocus, dual-LED flash	1.2 MP, 720p	1/2.5" sensor size, PureView technology, geo-tagging, face detection, panorama, HDR	5" AMOLED capacitive touchscreen, 16M colours

**Table 6: Comparison of most popular smartphone devices in Europe (II).**

	RAM	MEMORY	BATTERY	SENSORS	RESOLUTION	AP
<b>SAMSUNG GALAXY S6/EDGE</b>	3 GB RAM	32/64/128GB (UFS 2.0)	2550mAh	Accelerometer, Proximity, Light, Geo-magnetic, Gyro, Fingerprint, Barometer, Hall, HRM	1440 x 2560 (577 ppi)	Exynos 7420 (64-bit, 14nm), CPU Octa core (2.1GHz Quad + 1.5GHz Quad)
<b>IPHONE 6</b>	1 GB RAM DDR3	16/32/64/128 GB	1810 mAh	Fingerprint (front-mounted), accelerometer, gyro, proximity, compass, barometer	750 x 1334 pixels (~326 ppi pixel density)	Apple A8 CPU Dual-core 1.4 GHz Typhoon (ARM v8-based)
<b>LG G4</b>	3 GB RAM	32 GB	Removable Li-Ion 3000 mAh battery	Accelerometer, gyro, proximity, compass, barometer, color spectrum	1440 x 2560 pixels (~538 ppi pixel density)	Qualcomm MSM8992 Snapdragon 808 CPU Hexa-core (4x1.4 GHz Cortex-A53 & 2x1.8 GHz Cortex-A57)
<b>SAMSUNG GALAXY S5</b>	2 GB RAM	16/32 GB	Removable Li-Ion 2800 mAh battery	Fingerprint (front-mounted), accelerometer, gyro, proximity, compass, barometer, gesture, heart rate	1080 x 1920 pixels (~432 ppi pixel density)	Qualcomm MSM8974AC Snapdragon 801 CPU Quad-core 2.5 GHz Krait 400
<b>SAMSUNG GALAXY NOTE 4/EDGE</b>	3 GB RAM	32 GB	Removable Li-Ion 3220 mAh battery	Fingerprint (front-mounted), accelerometer, gyro, proximity, compass, barometer, gesture, UV, heart rate, SpO2	1440 x 2560 pixels (~518 ppi pixel density)	Qualcomm Snapdragon 805 Exynos 5433 CPU Quad-core 2.7 GHz Krait 450 - Snapdragon 805
<b>IPHONE 6+</b>	3 GB RAM	32/64/128 GB	Li-Ion 2550 mAh battery	Fingerprint (front-mounted), accelerometer, gyro, proximity, compass,	1080 x 1920 pixels (~401 ppi pixel density)	Apple A8 CPU Dual-core 1.4 GHz Typhoon (ARM v8-based)

	RAM	MEMORY	BATTERY	SENSORS	RESOLUTION	AP
				barometer, heart rate, SpO2		
<b>HTC ONE M9</b>	3 GB RAM	32 GB	Li-Po 2840 mAh battery	Accelerometer, gyro, proximity, compass	1080 x 1920 pixels (~441 ppi pixel density)	Qualcomm MSM8994 Snapdragon 810 CPU Octa-core (4x1.5 GHz Cortex-A53 & 4x2.0 GHz Cortex-A57)
<b>LG G3</b>	2/3 GB RAM	16/32 GB	Removable Li-Ion 3000 mAh battery	Accelerometer, gyro, proximity, compass	1440 x 2560 pixels (~538 ppi pixel density)	Qualcomm MSM8974AC Snapdragon 801 CPU Quad-core 2.5 GHz Krait 400
<b>NOKIA LUMIA 930</b>	2 GB RAM	32 GB	Li-Ion 2420 mAh battery (BV-5QW)	Accelerometer, gyro, proximity, compass, sensor core	1080 x 1920 pixels (~441 ppi pixel density)	Qualcomm MSM8974 Snapdragon 800 CPU Quad-core 2.2 GHz Krait 400

**Table 7: Comparison of most popular smartphone devices in the USA.**

	OS	DIMENSIONS	REAR CAMERA	FRONT CAMERA	CAMERA FEATURES	DISPLAY
<b>IPHONE 6</b>	iOS 8 to iOS 10.3	138.1 x 67 x 6.9 mm (129 g)	8 MP, f/2.2, 29mm, phase detection autofocus dual-LED (dual tone) flash,	1.2 MP, f/2.2, 31mm, 720p@30fps, face detection, HDR, FaceTime over Wi-Fi or Cellular	1/3" sensor size, 1.5 µm pixel size, touch focus, geo-tagging, face/smile detection, HDR (photo/panorama)	4.7" LED-backlit IPS LCD, capacitive touchscreen, 16M colours ion-strengthened glass, oleophobic coating
<b>IPHONE 5/5S/5C</b>	iOS 7 to iOS 10.3	123.8 x 58.6 x 7.6 mm (112 g)	8 MP, f/2.2, 29mm, autofocus, dual-LED (dual tone) flash	1.2 MP, f/2.4, 31mm, 720p@30fps, face detection, HDR, FaceTime over Wi-Fi or Cellular	1/3" sensor size, 1.5 µm pixel size, touch focus, geo-tagging, face/smile detection, HDR (photo/panorama)	4" LED-backlit IPS LCD, capacitive touchscreen, 16M colours
<b>IPHONE 6+</b>	iOS 8 to iOS 10.3	158.1 x 77.8 x 7.1 mm (172 g)	8 MP, f/2.2, 29mm, phase detection autofocus, OIS, dual-LED (dual tone) flash	1.2 MP, f/2.2, 31mm, 720p@30fps, face detection, HDR, FaceTime over Wi-Fi or Cellular	1/3" sensor size, 1.5 µm pixel size, touch focus, geo-tagging, face/smile detection, HDR (photo/panorama)	5.5" LED-backlit IPS LCD, capacitive touchscreen, 16M colours
<b>SAMSUNG GALAXY S5</b>	Android OS, v4.4.2 to v6.0	142 x 72.5 x 8.1 mm (145 g)	16 MP, f/2.2, 31mm, phase detection autofocus, LED flash	2 MP, f/2.4, 22mm, 1080p@30fps, dual video call	1/2.6" sensor size, 1.12 µm pixel size, geo-tagging, touch focus, face/smile detection, panorama, HDR	5.1" Super AMOLED capacitive touchscreen, 16M colours
<b>IPHONE 6</b>	<b>RAM</b>	<b>Memory</b>	<b>Battery</b>	<b>Sensors</b>	<b>Resolution</b>	<b>AP</b>
	1 GB	16/32/64/128 GB	1810 mAh	Fingerprint (front-mounted), accelerometer, gyro, proximity, compass, barometer	750 x 1334 pixels (~326 ppi pixel density)	Apple A8 CPU Dual-core 1.4 GHz Typhoon (ARM v8-based)
<b>IPHONE 5/5S/5C</b>	1 GB	16/32/64 GB	Li-Po 1560 mAh battery	Fingerprint (front-mounted), accelerometer, gyro, proximity, compass	640 x 1136 pixels (~326 ppi pixel density)	Apple A7 CPU Dual-core 1.3 GHz Cyclone (ARM v8-based)

	OS	DIMENSIONS	REAR CAMERA	FRONT CAMERA	CAMERA FEATURES	DISPLAY
<b>IPHONE 6+</b>	3 GB	32/64/128 GB	Li-Ion 2550 mAh battery	Fingerprint (front-mounted), accelerometer, gyro, proximity, compass, barometer, heart rate, SpO2	1080 x 1920 pixels (~401 ppi pixel density)	Apple A8 CPU Dual-core 1.4 GHz Typhoon (ARM v8-based)
<b>SAMSUNG GALAXY S5</b>	2 GB	16/32 GB	Removable Li-Ion 2800 mAh battery	Fingerprint (front-mounted), accelerometer, gyro, proximity, compass, barometer, gesture, heart rate	1080 x 1920 pixels (~432 ppi pixel density)	Qualcomm MSM8974AC Snapdragon 801 CPU Quad-core 2.5 GHz Krait 400

Based on this data we can conclude that an operating system of minimum Android v6.0 as well as iOS 10 are available for these devices. The phones all have a size greater than 123.8 x 58.6 x 7.6 mm, and weight in between 112-176 grams. They also have a camera of at least 8 mega pixels. These phones also have a resolution greater or equal to 1080 x 1920. All these phones offer either 16, 32, or 64 gigabytes of storage, and have at least 1 GB of RAM. They all contain a battery of more than 1810 mAh. When it comes to sensors they all have an accelerometer, gyro, proximity, and compass, but several phones also have fingerprint sensors and/or barometers.

## 2.2 Handheld device usage of people with differences and difficulties associated with perception, memory, cognition and communication

Using Accesswireless.org a list of features needed by people with mobility, hearing/speech, visual, and cognitive impairments was identified. Then, we compared these features with the most popular smartphones in the USA and Europe and comprised a matrix (see Annex A) to make their respective advantages and disadvantages.

The most popular cell phones contained almost all the features that are supporting the target audiences. The device which supported the most features is the Samsung Galaxy Note 4 edge which contains 84 of these features. In second place was the LG G3 which contained 83 of these features.

## 2.3 Individual research on device usage in the participating museums and specific target audiences

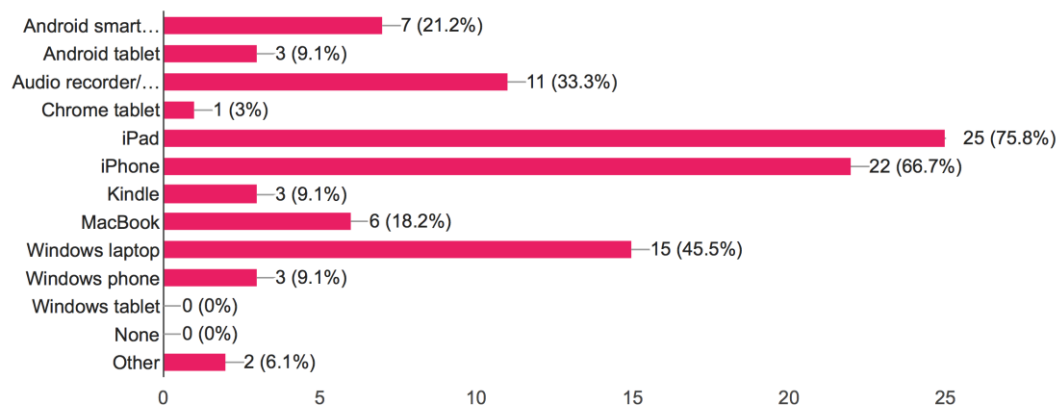
### 2.3.1 Research data from the exploration groups in the UK

The active involvement of the exploration groups in the activities organised by The Open University and University of Bath at The Wallace Collection (WC) and the Victoria & Albert Museum (V&A) contributed to better identifying which are the most popular handheld devices for people with differences and difficulties associated with perception, memory, cognition and communication.

The information collected by means of an interactive survey is summarised in Figure 3.



## 11. What technology do you use?(You may tick more than one) (33 responses)



**Figure 3: Devices used by the exploration group at The Wallace Collection and the Victoria & Albert Museum.**

### 2.3.2 Feedback from the other participating museums

Since the exploration groups that will participate in the activities to be periodically organised at the Austrian and Spanish museums have not been built yet (this activity will start in October 2017), there is still no feedback from them. Therefore, our first approach relies on identifying the handheld devices that are available at the museum's facilities and may be used by the groups.

#### 2.3.2.1 Thyssen-Bornemisza Museum

The Thyssen-Bornemisza Museum (Thyssen) is currently already owning a set of handheld devices which are used for people with functional disability. In particular there are 30 tablets Samsung Galaxy Tab S2 8" Wi-Fi 32 GB, whose main features are:

- Speed: CPU 1.9GHz, 1.3GHz . Type CPU Octa-Core
- Memory:
  - 3 GB Available memory
  - 25.1 GB Internal memory
  - 32 GB External MicroSD (up to 128GB)
- Camera:
  - Video Resolution QHD (2560 x 1440)@30fps
  - Main Camera Resolution: CMOS 8.0 MP
  - Front Camera: CMOS 2.1 MP
  - Principal Camera: Autofocus
- Video reproduction formats: MP4, M4V, 3GP, 3G2, WMV, ASF, AVI, FLV, MKV, WEBM
- Video reproduction resolution UHD 4K (3840 x 2160) @30fps
- Audio reproduction formats: MP3, M4A, 3GA, AAC, OGG, OGA, WAV, WMA, AMR, AWB, FLAC, MID, MIDI, XMF, MXMF, IMY, RTTTL, RTX, OTA

- Android Operative System (6.0.1)
- ANT Connectivity+ USB USB 2.0 Version
- GPS/Glonass localisation
- Headphones 3.5mm Stereo MHL
- Wi-Fi Direct Wi-Fi 802.11 a/b/g/n/ac 2.4G+5GHz, VHT80 MIMO
- Bluetooth v4.1 Bluetooth Profiles A2DP, AVRCP, DI, HID, HOGP, HSP, OPP, PAN PC Sync. Smart Switch (PC version).

While the devices are used to show materials, the museum does not have any specific apps for people with functional disability oriented towards perception, memory, cognition and communication. Therefore, no previous experiences regarding the systems stability for such apps can be called upon. However, the devices used were released less than 2 years ago which puts them close to state of the art devices that are popular now.

Thyssen also uses sign language guides “Opus Click”. Their key features include:

- Full colour TFT LCD screen
- Large, expandable memory
- Compatible with a complete range of audio, video, image and animation multimedia formats
- Dual listening mode, via internal speaker and/or through headset/earpiece
- Keyboard or tactile
- Visual capacity of an MP4
- Remote activation via IR & RF
- Opus Content Manager - easy set up and install, can be used by client
- Custom operating system

They currently offer information about 20 art pieces from the Thyssen collection. There is a limited amount of content, only from the permanent collection, which prevents people from returning to the museum. Some of the visitors with hearing impairments have implants, therefore, they can take advantage of audio description which goes together with the sign language video.

### 2.3.2.2 Lázaro Galdiano Museum

The Lázaro Galidiano Museum (FLG) owns and offers a set of 20 handheld devices and a mobile application (available for iOS and Android) with several routes (including an accessible route). The rental tablets are Samsung Galaxy Tab 3 and have the following features:

- Dimensions: 188 x 111.1 x 9.9 mm (7.40 x 4.37 x 0.39 in)
- Weight: 306 g (10.79 oz)
- Display: TFT capacitive touchscreen, 16M colours
- Size: 7.0 inches (~66.0% screen-to-body ratio)
- Resolution 600 x 1024 pixels (~170 ppi pixel density)

- Multitouch
- Android OS, v4.1.2 (Jelly Bean)
- Chipset: Marvell PXA986
- CPU: Dual-core 1.2 GHz Cortex-A9
- GPU: PowerVR SGX540
- Memory: up to 64 GB (dedicated slot)
- Internal: 8/16 GB, 1 GB RAM
- Camera: 3.15 MP
- Video: 720p@30fps
- MP4/DivX/Xvid/H.264/WMV player
- MP3/WAV/eAAC+/WMA/Flac player
- Secondary Camera: 1.3 MP
- WLAN Wi-Fi 802.11 a/b/g/n, dual-band, Wi-Fi Direct, DLNA, hotspot
- Bluetooth: v3.0, A2DP
- Sensors: Accelerometer, gyro, proximity, compass

Finally, there is also one Apple iPad is used for educational purposes (see section 2.1 for further details).

### 2.3.2.3 Fine Arts Museum of Asturias

The Fine Arts Museum of Asturias (MBBAA) is currently in the process of acquiring tablets in order to provide guides to the visitors. The most likely candidate is the Apple iPad but the decision has not been taken yet.

### 2.3.3 Research data from deaf persons in Austria

Research within a community of 30 deaf persons (n=30) was conducted to find out the smartphone devices used. We specifically asked also about the use of Android and iOS devices, to also get a distribution between the two mayor operating system providers. Results are presented in Table 8.

**Table 8: Smartphones used by deaf persons (n=30).**

SMARTPHONE	# OF USERS
IPHONE 6	6
IPHONE 6S	4
IPHONE 7	5
HUAWEI P8	3
HUAWEI P6	2
SAMSUNG GALAXY S4	3
SAMSUNG GALAXY S5	3
SAMSUNG 5J	1
NO ANSWER/NO DEVICE	3

When it comes to tablets, the interviewees did not know the exact brand. However they know the operating system and this is presented in .

**Table 9: Tablet operating systems used by deaf persons (n=30).**

TABLET	# OF USERS
ANDROID	9
IOS	5
NO ANSWER/NO DEVICE	16

We also asked about the reasoning behind the choice of device and got the following answers:

- Device was offered by the provider as part of the contract.
- Support for high data speeds and volumes (also connected to the contract).
- Friends/Family members own the same devices and recommend them.

### 2.3.4 Experience report from working with serious games for kids with special needs

The following data is derived from working with schools for kids with special needs, parents of kids with special needs, Non-Governmental Organisations (NGOs) that deal with the subject, regular schools that have kids with special needs in inclusive classrooms etc.:

- Screens for any tablet should be over 7 inch, due to eye strain and hand coordination.
- The hardware platform that was preferred based on quality of screen and touch matrix was always Apple iPad, no matter the model. However, the down side for iPads was that they did not have the vibration / haptic feedback.
- iPads by far have the best touch matrix and are the easiest to setup and control due to the closed environment.
- When it comes to Android devices, the same model can have a different touch matrix depending of the series which can be quite problematic in the long run.
- Different Android OS versions that are locked and not able to be upgraded also create long term problems.
- The extremely fragmented screen size and screen quality on the android market is problematic in the long term.
- The extremely fragmented audio quality on the android market is problematic in the long term.
- On Android devices, the physical design of the device can sometimes be problematic due to the heating of the screen and etc. This problem does not exist on iOS devices.
- It is a lot easier to publish on play store than it is on the app store for apple.
- The approval process on the app store takes significant time and should be considered in the process.
- The testing process on iOS is cumbersome for a test batch larger than 15 devices.
- A remote device management tool is necessary to fully control the devices and ensure a good experience for the users.

### 3 Conclusions

This document has been conceived as a perfect complement to deliverable D3.1 “Report on system architecture definition” under WP3 “Development of an accessible platform system”. There the architecture was described taking into consideration the important role played by the handheld devices (mainly smartphones and tablets) in the overall approach of the ARCHES project. It was also pointed out how the functionalities and applications to be implemented in the framework of WP4 “Development of applications for handheld devices” will be integrated so as to re-use data and information stored in the repositories, especially the one oriented to multimedia resources.

In this report we have presented general statistics and figures corresponding to the market share of the most popular smartphones and tablets for Europe and the USA. The analysis of the collected inputs will be very valuable for the decisions to be taken all along the development and validation phase, especially regarding the needs and motivations of people with differences and difficulties associated with perception, memory, cognition and communication. In fact, the feedback from the exploration group participating in the weekly sessions organised at The Wallace Collection and the Victoria & Albert Museum in London has shown that they really prefer iOS (iPhone and iPad) to Android. Nevertheless, this trend may be different in Spain and Austria, where the Android share is higher than in the UK. This will thoroughly studied once the Spanish and Austrian exploration groups are built in October 2017. In any case, the technology developers participating in ARCHES are committed to develop iOS and Android versions for the envisioned applications.

The identification of the most common features of smartphones allowed us to make a comparison among the most popular smartphones on the market. Since the exploration groups will assess whether each of the features are relevant for them, we will be able to select the both the most suitable models and the most interesting functionalities to be incorporated into the applications.

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## Annex A Comparison of most popular smartphones and specific features which support people with special needs

		Samsung Galaxy S6/Edge	iPhone 6	LG G4	Samsung Galaxy S5	Samsung Galaxy Note 4/Edge	iPhone 6+	HTC One M9	LG G3	Nokia Lumia 930	Sony Xperia Z3	iPhone 6	iPhone 5/5S/5C	iPhone 6+	Samsung Galaxy S5	iPhone 4/4S	
<b>MOBILITY/DEXTERITY FEATURES</b>	<b>Description</b>																
Supports Gesture Based Navigation	You can use simple gestures to enter text or navigate your device (e.g., Back, Home).	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A	N/A	Yes	Yes	Yes	Yes	Yes	Yes
Stylus or Prosthetic Device support	Do buttons and screen respond to a prosthetic device, pointing device or stylus? A prosthetic device is an artificial device that serves as a replacement for a body part.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes
External Switch / Pointer Support	You can connect an external switch or use head and/or eye movements to move the focus or pointer on the device's screen.	No	Yes	Yes	No	Yes	Yes	No	Yes	No	N/A	Yes	Yes	Yes	No	Yes	Yes

		Samsung Galaxy S6/Edge	iPhone 6	LG G4	Samsung Galaxy S5	Samsung Galaxy Note 4/Edge	iPhone 6+	HTC One M9	LG G3	Nokia Lumia 930	Sony Xperia Z3	iPhone 6	iPhone 5/5S/5C	iPhone 6+	Samsung Galaxy S5	iPhone 4/4S
Visible Focus Indicators	Visible indicators are used to highlight the user interface control with current focus.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A	Yes	Yes	Yes	Yes	Yes
Voice Recognition for Accessing Features	Allows you to activate features by speaking commands into the phone, reducing the need to use the keypad.	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Hand Movement	Controls do not require you to pinch or twist them with your fingers, or rotate your wrist.	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	Yes	Yes
Voice Recognition for Dialing	Allows you to dial a number by speaking the person's name, if it is stored in your contact list (a personal 'telephone book' you create in your phone).	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Any Key Answering	Can the user answer the call by pressing any key?	No	No	No	No	Yes	No	No	No	No	N/A	No	No	No	No	N/A
Automatic Redial	You can set it to automatically redial if the number you	No	Yes	No	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes



		Samsung Galaxy S6/Edge	iPhone 6	LG G4	Samsung Galaxy S5	Samsung Galaxy Note 4/Edge	iPhone 6+	HTC One M9	LG G3	Nokia Lumia 930	Sony Xperia Z3	iPhone 6	iPhone 5/5S/5C	iPhone 6+	Samsung Galaxy S5	iPhone 4/4S
Automatic Answer	called is busy or unavailable. You can set it to answer all calls automatically without you having to do anything.	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No	No	No	No	No	Yes	N/A
Flat Back for Table Top Operation	Has a flat back, so it can be used while it is lying on a table.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Device Coupling - Bluetooth/WLAN	Allows customised devices to work with the phone. Device can be connected to the phone by using Bluetooth/wireless LAN (radio signals which travel through the air and may also be able to pass through walls or other solid objects).	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Device Coupling - Infrared	Allows customised devices to work with the phone. Device can be connected to the phone by using infrared signal (which travels through the air like a	Yes	No	Yes	Yes	Yes	No	No	Yes	No	No	No	No	No	Yes	No

		Samsung Galaxy S6/Edge	iPhone 6	LG G4	Samsung Galaxy S5	Samsung Galaxy Note 4/Edge	iPhone 6+	HTC One M9	LG G3	Nokia Lumia 930	Sony Xperia Z3	iPhone 6	iPhone 5/5S/5C	iPhone 6+	Samsung Galaxy S5	iPhone 4/4S
	radio wave but cannot pass through walls or other solid objects).															
Device Coupling - Cable	Allows customised devices to work with the phone. Device can be connected to the phone by using a cable (an electrical wire).	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Guarded/Recessed Keys	Individual keys are recessed or guarded in some way to reduce the chance that you will press the wrong key.	N/A	N/A	Yes	N/A	N/A	Yes	Yes	Yes	N/A	N/A	N/A	Yes	Yes	N/A	N/A
Predictive Text Input	Helps you write text messages more quickly by predicting words from the first few letters you type.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Text Messaging Service Capable	Can all the text message features supported be read, composed and sent using the phone's	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

		Samsung Galaxy S6/Edge	iPhone 6	LG G4	Samsung Galaxy S5	Samsung Galaxy Note 4/Edge	iPhone 6+	HTC One M9	LG G3	Nokia Lumia 930	Sony Xperia Z3	iPhone 6	iPhone 5/5S/5C	iPhone 6+	Samsung Galaxy S5	iPhone 4/4S
	screen and/or keypad.															
Speaker-phone capable	Hands free operation during dialing and after the call has been initiated.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<b>VISION FEATURES</b>	<b>Description</b>															
Audible Cues - Enhancements	Makes a sound when an accessory is connected or disconnected.	N/A	N/A	N/A	N/A	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Audible Cues - Charging	Makes a sound when the battery/device has reached full charge or when you tab on the battery icon.	N/A	N/A	N/A	N/A	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Screen Reader	A mode in which onscreen information is made available via text to speech and the device is operable without vision.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes
Screen Magnifier	Does the screen magnifier enlarge all	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes

		Samsung Galaxy S6/Edge	iPhone 6	LG G4	Samsung Galaxy S5	Samsung Galaxy Note 4/Edge	iPhone 6+	HTC One M9	LG G3	Nokia Lumia 930	Sony Xperia Z3	iPhone 6	iPhone 5/5S/5C	iPhone 6+	Samsung Galaxy S5	iPhone 4/4S
	views, including the web?															
Braille Display Support	Does the device support a braille display?	No	Yes	Yes	No	No	Yes	No	Yes	No	N/A	Yes	Yes	Yes	No	Yes
Web Browser Zoom	You can magnify web content when using the internet browser.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Speed Dial	You can assign speed dial short cut keys to your contacts.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Supports Accessibility APIs	APIs allow accessibility software programs to communicate with the device (although there may be some limits).	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
High Contrast Mode	The phone comes with at least one high contrast mode.	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Display Characteristics - Symbols/Icons	Menus can be displayed using symbols or pictures in a grid layout. This can make them easier for some	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

		Samsung Galaxy S6/Edge	iPhone 6	LG G4	Samsung Galaxy S5	Samsung Galaxy Note 4/Edge	iPhone 6+	HTC One M9	LG G3	Nokia Lumia 930	Sony Xperia Z3	iPhone 6	iPhone 5/5S/5C	iPhone 6+	Samsung Galaxy S5	iPhone 4/4S
Display Characteristics - Colour Differentiation	people to understand or remember. The information presented on the display does not rely on colour perception for understanding (e.g. you do not have to be able to distinguish red symbols from green symbols).	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Display Characteristics - Backlight for Display	The display lights up to make it easier to read in the dark.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Display Characteristics - Adjustable Brightness Control	You can adjust the brightness of the display to make it easier to read.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Voice Output of Caller ID from Contacts List	When you receive a call, it speaks the caller's name if it is stored in your contact list.	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Voice Output of SMS: inbuilt	Can read text messages out loud to you.	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes

		Samsung Galaxy S6/Edge	iPhone 6	LG G4	Samsung Galaxy S5	Samsung Galaxy Note 4/Edge	iPhone 6+	HTC One M9	LG G3	Nokia Lumia 930	Sony Xperia Z3	iPhone 6	iPhone 5/5S/5C	iPhone 6+	Samsung Galaxy S5	iPhone 4/4S
Display Characteristics - Adjustable Contrast Control	You can adjust the contrast of the display to make text and symbols easier to see against the background.	Yes	No	Yes	Yes	Yes	No	No	Yes	No	No	No	No	No	Yes	Yes
Voiced Menus	Speaks the menu options, allowing you to access functions even if you cannot read the display.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Ring Tone Variations	You can set it to use different ring tones for different people when they call you.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Voice Recognition for Dialing or Accessing Features	Voice Commands can be used for dialing or accessing features on the phone.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Personalized Shortcuts	You can assign a particular feature to a single key or a short key sequence.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A	Yes	Yes	Yes	Yes	Yes
Automatic Features - Automatic Answer	Does the phone support automatic answering of calls?	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No	No	No	No	No	Yes	N/A

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Adjustable Font - Size	You can make the text on the display larger or smaller to make it easier to read.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjustable Font - Style	You can change the font (typeface) used for the text on the display, which may make it easier to read.	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No	No	No	No	No	Yes	No
Audible Cues - Volume	Is there a audible cue to indicate a change in the volume level?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Audible Cues - Calls	If another call comes in while you are still on a call, it makes a sound to tell you there is a call waiting.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Audible Cues - Power	Makes a sound when you press the power on/off button, so you know it has been pressed.	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes
Audible Cues - Battery	Makes sounds to tell you when the battery is running	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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	out or when it is recharging.															
Audible Identification of Keys - Functions	The sounds you hear when you press a key are different for number keys and function keys, so you can easily tell them apart.	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	No	No	Yes	Yes
Audible Identification of Keys - Spoken	When you press a number key the number is spoken out, so you know you have pressed the correct one.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Key Feedback - Audible	When you press a key it makes a sound, so you know it has been pressed.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Key Feedback - Tactile	When you press a key you can feel a physical click, so you know it has been pressed.	Yes	No	Yes	Yes	Yes	Yes	No	Yes	N/A	Yes	No	Yes	Yes	Yes	N/A
Standard Number Key Layout	The number keys are laid out in the standard way with 1 2 3 at the top and * 0 # at the bottom.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes



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Tactile Key Marker - '5'	The number '5' key has a raised dot or bump on it so you can distinguish it by touch.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tactile Key Markers - 'F' & 'J'	The 'F' and 'J' keys have raised dots or bumps on them so you can distinguish them by touch (only relevant for phones that have a QWERTY typewriter-style keypad).	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
<b>HEARING/SPEECH FEATURES</b>																
	<b>Description</b>															
Hearing Aid or "HAC" Setting	The device has a user setting designed to reduce issues related to interference buzzing for hearing aid users in telecoil mode. Does not guarantee total clarity.	N/A	Yes	No	No	No	Yes	No	Yes	No	N/A	Yes	Yes	Yes	No	Yes
Adjustable Vibrating Alerts	Allows users to select different vibration settings for various notifications.	No	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes

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Supports Closed Captioning for Web Video or Streaming	Device is capable of displaying closed captioning that is included in a video or video stream.	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Front Facing Camera	Allows the front facing camera to be used in signing or two-way video conferencing.	Yes	Yes	Yes	Yes	Yes	Yes	No	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjustable Maximum Volume Control	Allows you to change the default volume control limit.	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Two-way Video Communications – using wireless LAN networks	Allows you to make video calls in which you can see the other person and they can see you using your wireless LAN network.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Two-way Video Communications – using mobile networks	Allows you to make video calls in which you can see the other person and they can see you using your mobile network.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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Visual Alerts - Electronic Message	When a text, e-mail or IM comes in, it displays a visual alert to indicate it has been received.	Yes	Yes	Yes	M3/T3	M4/T3	Yes	Yes	M4/T3	Yes	Yes	Yes	Yes	Yes	M3/T3	Yes
Text phone/TTY compatibility	This product is compatible with the Textphone/TTY for the deaf.	No	M3,T4	No	Yes	Yes	M3, T4	N/A	Yes	Yes	M3/T3	M3,T4	M3, T4	M3, T4	Yes	N/A
Call Logs	Lists all the calls you have dialled, received or missed.	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	N/A	Yes	Yes	Yes	Yes	Yes
Ringer Volume Adjustable	You can adjust the ringing volume to make it louder or quieter.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Key Feedback - Displayed	When you press the number keys the number is displayed on the screen so you can check that it is correct before dialling.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hearing Aid T-coil Coupling	The device is able to connect with a sufficiently immune hearing aid in "Telecoil mode" without significant interference buzzing	N/A	Yes	No	Yes	Yes	Yes	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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	noise. Does not guarantee total clarity.															
Video Conferencing	Whether Two-way Video Conferencing is supported.	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SMS Personalisation and Reuse	Allows you to create standard text messages that you can quickly send to anyone without having to retype them each time. For example, "I'm in a meeting, I'll call you back".	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Messaging Options - Predictive Text	Helps you write text messages more quickly by predicting words from the first few letters you type.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Messaging Options - MMS	You can send and receive multimedia messages, which can include photographs, audio and video clips.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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Messaging Options - IM	You can send and receive 'instant messenger' (IM) messages.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Messaging Options - Email	Whether email is supported.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Messaging Options - Text Messaging/SMS	You can send and receive text messages.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Visual Indicators on Display - Enhancements	Whether there is a visual indicator on the display to indicate whether any enhancements are connected (Loopset, Headset or TTY/Textphone).	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Visual Indicators on Display - Line Status	Whether there is a visual indicator on the display to indicate the line status (i.e on-line).	Yes	Yes	Yes	Yes	Yes	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Visual indicators on Display - Voice Mail	When someone has left a voice mail message, it displays a visual alert.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Visual Indicators on Display - Volume Control	The display shows the current volume level.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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Visual indicators on Display - Network	The display shows what type of network you are connected to (e.g. 3G/LTE or WiFi).	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Visual Indicators on Display - Battery	The display shows the current battery strength and the network signal strength.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Visual Alerts - Incoming Calls	When a call comes in, it displays a visual alert, such as the caller's name or photo if it is stored in your contact list.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Visual Alerts - Other	Whether there are other visual alerts /text displays that are not mentioned above.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Visual Alerts - Battery	Displays a visual alert to tell you when the battery is running out or when it is recharging.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Visual Alerts - Power	When you press the power on/off button a visual alert is shown (e.g. a light),	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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	so you know it's been pressed.															
	The phone can be set to vibrate when it receives a call or text message or when it gives a warning alert.															
Vibrating alert		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Can the device be adjusted to improve call quality against ambient noise?															
Improved Call Quality		No	Yes	No	Yes	Yes	Yes	No	No	No	No	Yes	Yes	Yes	Yes	No
<b>COGNITION FEATURES</b>																
	<b>Description</b>															
	Allows you to record, save and play back a short voice reminder.															
Voice Notes		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes
	Allows you to disable or conceal unneeded features/programs or icons.															
Simplify Display		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	The device has Global Positioning System (GPS) capability.															
GPS Capability		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Does the device support a copy and															
Copy and Paste		Yes	Yes	Yes	N/A	Yes	Yes	Yes	Yes	N/A	N/A	Yes	Yes	Yes	N/A	Yes

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Simple Instructions	paste functionality for text entry?  Instructions and messages that are displayed on screen use simple language.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Photo Associated Telephone Book	You can add photos of people next to their numbers in your contact list (a personal 'telephone book' you create in the phone).	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Assistance Instructions	When you need to provide input (e.g. when setting up the phone or when it asks you a question), extra helpful instructions are provided, explaining what you need to do.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Simple Reminders	All text alerts and other reminders that are displayed on the screen use simple, easy to understand language.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes



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<p>No Screen Timeout</p> <p>When the phone displays an alert or a question that requires you to give an answer, e.g. by clicking a "Yes" or "No" button or by typing in your PIN number, it will wait for your response. This can be helpful for people who find it difficult to decide what to answer or to enter the answer quickly.</p>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes