SMART PHONE PERFORMANCE COMPARISON: INTEL-POWERED LENOVO K900 VS. INDUSTRY-LEADING PHONES

In the early years of smart phones, consumers typically cared most about apps and features. As the smart phone market has matured, with a majority of the leading phones on the market boasting comparable apps and features, a new area of differentiation has emerged: performance.

Thanks to the new Intel Atom processor Z2580, the new Lenovo K900 smart phone excels in doing what users care most about—running their favorite apps and games speedily and quickly browsing the Internet with ease.

In the Principled Technologies labs, we tested the Lenovo K900 and five other industry-leading smart phones: the Apple iPhone 5, the Google Nexus 4, the HTC One, the Samsung Galaxy S III, and the Samsung Galaxy S4.

We found that the Intel processor-based Lenovo K900 did the best on mobile performance tests—up to 82.7 percent better. When launching popular games, the Lenovo K900 was generally as fast as or faster than the HTC One, Google Nexus 4, and the two Samsung Galaxy phones (the Apple iPhone was the fastest).

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SMART PHONES HAVE PROCESSORS, TOO

Many of us are aware of processors in our computers but don't realize that processors also drive our smart phones. The powerful new dual-core Intel Atom processor Z2580 (part of the Clover Trail+ platform family) brings a number of advantages to the Lenovo K900 smart phone, the most obvious of which is power to boost performance.

To learn about the performance of the new Intel-based Lenovo K900, we tested it along with the following five competing phones: the Apple iPhone 5, the Google Nexus 4, the HTC One, the Samsung Galaxy S III, and the Samsung Galaxy S4.

We found that the Intel-based Lenovo K900 generally delivered superior performance. Appendix A provides detailed configuration information for the smart phones. Appendix B provides the details of our testing.

MEASURING PERFORMANCE

No one likes a sluggish phone. To learn about the performance of the six smart phones in our study, we conducted four industry-standard benchmark tests (see Appendix C for more information about the benchmarks). We conducted each test three times and report the median score.

WebKit SunSpider 0.9.1

SunSpider is a benchmark that tests JavaScript engine performance on Web browsers. A lower time on the benchmark translates to less waiting for the user. As Figure 1 shows, the Intel-powered Lenovo K900 ran the SunSpider 0.9.1 benchmark in 727.7 milliseconds, 7.2 percent more slowly than the Samsung Galaxy 4 and up to 62.9 percent faster than the other four smart phones we tested.

What is a benchmark?

A benchmark is a tool that provides a standard for comparison. Each of the three benchmarks we used required the smart phones to perform a standard workload. They then reported the smart phone's performance using either a time (lower times are better) or a score (higher scores are better).

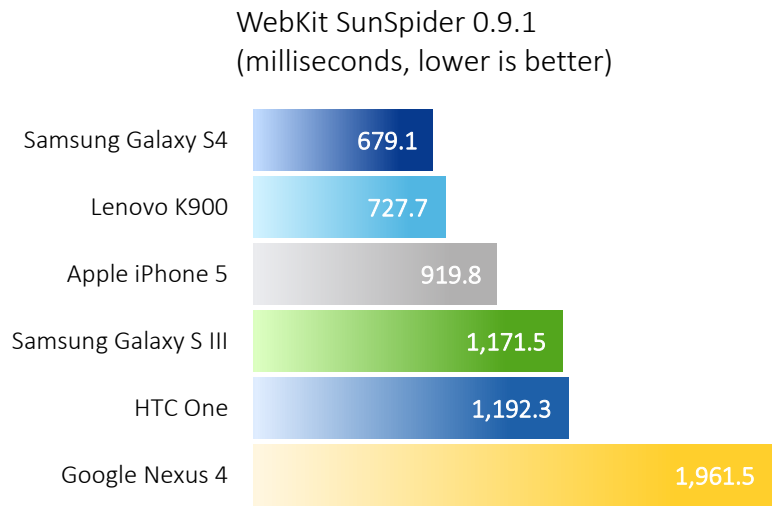

Figure 1: The Intel-powered Lenovo K900 outperformed four of the five other industry-leading smart phones on the WebKit SunSpider 0.9.1 benchmark.

Google Octane v1

Google Octane is a modern benchmark that measures JavaScript engine performance. A higher score translates to a better experience for the user. As Figure 2 shows, the Intel-powered Lenovo K900 achieved an Octane score of 2,837, up to 125.3 percent higher than four of the other five smart phones we tested. Only the Samsung Galaxy S4 achieved a higher score.

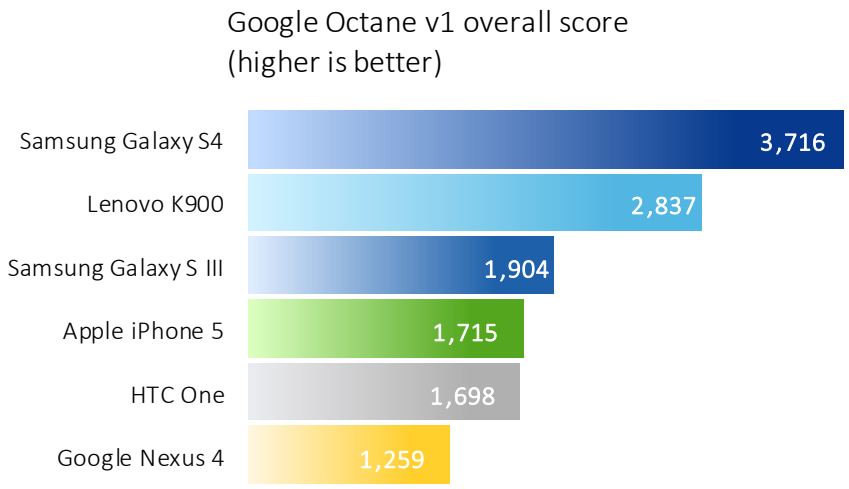

Figure 2: The Intel-powered Lenovo K900 outperformed four of the five other industry-leading smart phones on the Octane v1 benchmark.

WebXPRT 2013

WebXPRT 2013 is a benchmark that compares the performance of almost any Web-enabled device. A higher score translates to a better experience for the user. As Figure 3 shows, the Intel-powered Lenovo K900 achieved a WebXPRT 2013 score of 274, up to 82.7 percent higher than the other five smart phones we tested.

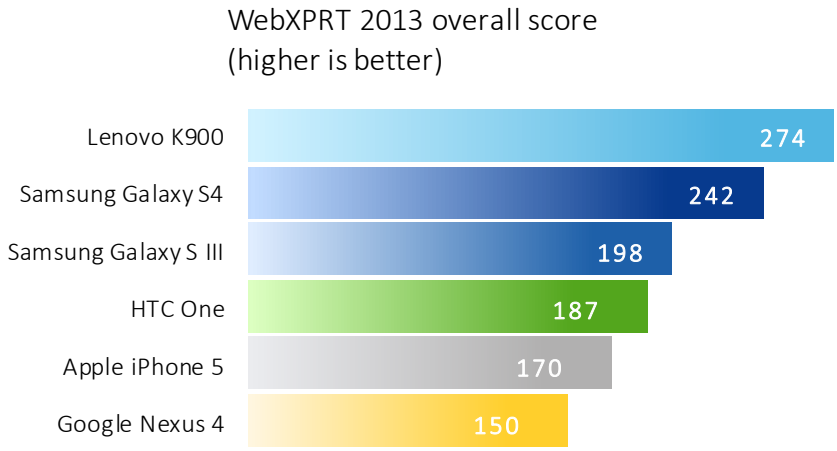

Figure 3: The Intel-powered Lenovo K900 outperformed the five other industry-leading smart phones on the WebXPRT 2013 benchmark.

MobileXPRT 2013

Based on real-world scenarios, MobileXPRT is a benchmark that evaluates smart phone performance and provides a fair and consistent basis for comparing the growing range of devices on the market. A higher score translates to a better experience for the user. As Figure 4 shows, the Intel-powered Lenovo K900 achieved a MobileXPRT 2013 score of 171, up to 48.7 percent higher than three of the other four smart phones we tested. The Samsung Galaxy S4 achieved a slightly higher score. Note: At the time of our testing, MobileXPRT 2013 supported only the Android™ operating system, so we were unable to run it on the Apple iPhone.

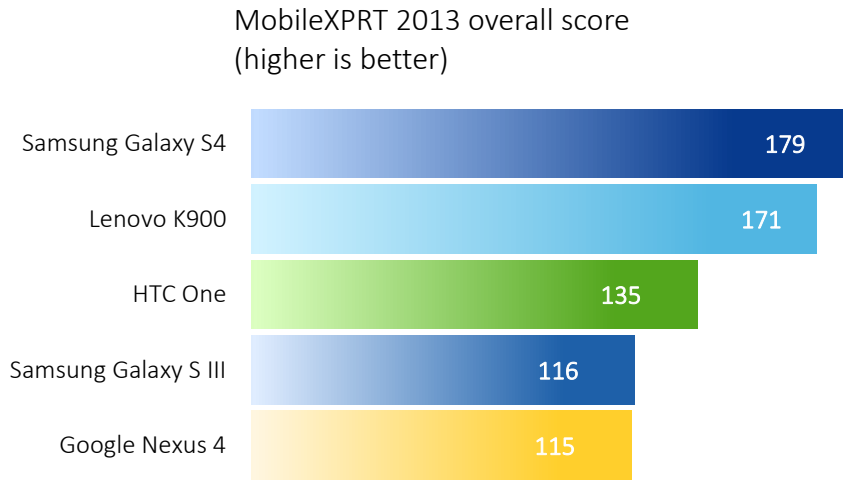

Figure 4: The Intel-powered Lenovo K900 outperformed three of the four other industry-leading smart phones we tested on the MobileXPRT 2013 benchmark.

MEASURING GAME LAUNCH TIME

When you want to play a game, you don't want to wait for it to load. To learn about the game-launching performance of the six smart phones in our study, we measured the time each needed to launch two popular games. We conducted each test three times and report the median score.

Asphalt 7: Heat

As Figure 5 shows, the Intel-powered Lenovo K900 launched Asphalt 7: Heat in 8.7 seconds, up to 23.1 percent faster than four of the other five smart phones we tested. The Apple iPhone 5 loaded this game in less time.

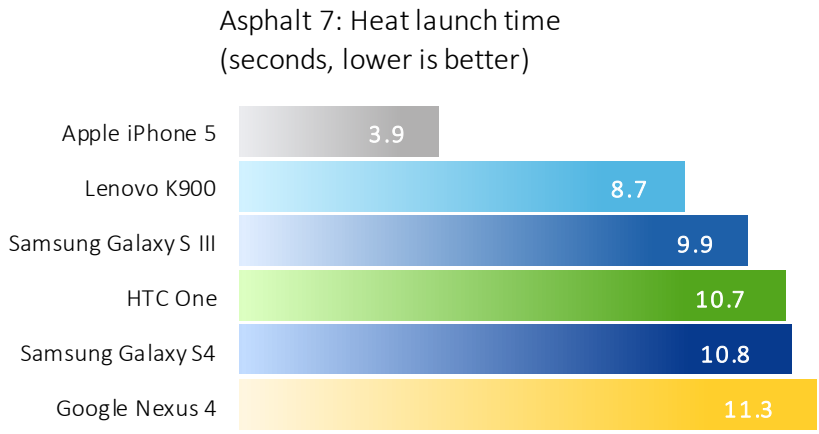

Figure 5: The Intel-powered Lenovo K900 loaded Asphalt 7: Heat more quickly than four of the five other industry-leading smart phones.

Epic Citadel

As Figure 6 shows, the Intel-powered Lenovo K900 launched Epic Citadel in 11.5 seconds, the same as the Samsung Galaxy S4, faster than three of the other phones, and more slowly than the Apple iPhone 5.

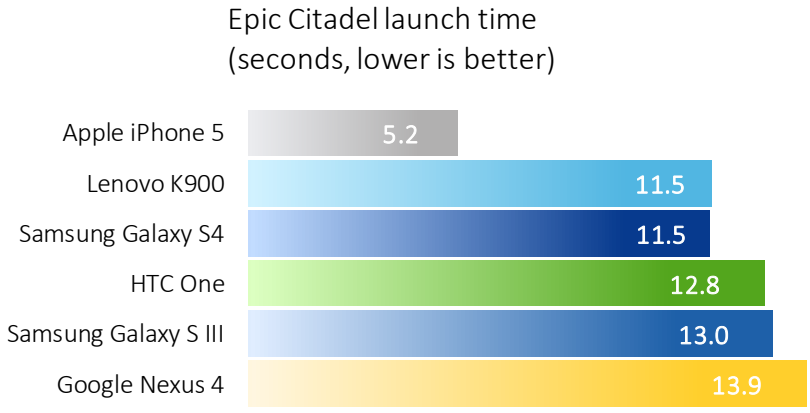

Figure 6: The Intel-powered Lenovo K900 loaded Epic Citadel faster than three of the five other industry-leading smart phones did.

COMPARING CAMERA SPECIFICATIONS AND FEATURES

Cameras have become an important component of smart phones, often becoming the main camera for many users. We investigated the cameras of the six phones we tested. Figure 7 summarizes the features of the cameras in the six phones we studied. See Appendix D for a more complete list of camera features.

	Lenovo K900	Apple iPhone 5	Google Nexus 4	HTC One	Samsung Galaxy S III	Samsung Galaxy S4
Front-facing camera megapixels	2	1.2	1.3	2.1	1.9	2
Rear-facing camera megapixels	13	8	8	4	8	13
Maximum aperture or f-stop (smaller numbers are better)	f/1.8	f/2.4	f/2.4	f/2.0	f/2.6	f/2.2
ISO settings	Auto, 100, 200, 400, 800	Auto	Auto	Auto, 100, 200, 400, 800, 1600	Auto, 100, 200, 400, 800	Auto, 100, 200, 400, 800
White balance	Auto, Incandescent, Daylight, Fluorescent, Cloudy	Auto	Auto, Incandescent, Daylight, Fluorescent, Cloudy	Auto, Incandescent, Daylight, Fluorescent, Cloudy	Auto, Incandescent, Daylight, Fluorescent, Cloudy	Auto, Incandescent, Daylight, Fluorescent, Cloudy
Exposure settings	-5, -4, -3, -2, -1, 0, +1, +2, +3, +4, +5	Auto	-2, -1, 0, +1, +2	Auto	Auto	Auto
Maximum number of shots captured using Burst mode	10	Not supported	Not supported	20	8	8
Shots captured per second using Burst mode	10	Not supported	Not supported	8	5	6
Savable shots per burst	1	Not supported	Not supported	1	1	1
Maximum number of shots captured using Continuous mode	100	Not supported	Not supported	99	20	20
Shots captured per second using Continuous mode	5	Not supported	Not supported	9	6	10
Savable shots per continuous shooting	100	Not supported	Not supported	99	20	20
Default camera picture size resolution	2,304 x 4,096	2,448 x 3,264	2,448 x 3,264	1,520 x 2,688	2,448 x 3,264	2,322 x 4,128

Figure 7: Summary of camera specifications and features for the phones we tested.

The Intel-powered Lenovo K900's camera boasted the largest aperture, or lens opening, of the cameras we looked at. Note: Camera apertures are typically expressed as ratios known as f-stops. Somewhat confusingly, a smaller f-stop indicates a larger opening, which translates to more light entering the camera and higher-quality photographs. The Lenovo K900 camera's f-stop is 1.8, which means its aperture is considerably larger than those of the cameras in the other phones are. The Lenovo K900 using Burst mode was also able to capture 10 shots per second and in Continuous mode was able to capture 100 consecutive shots.

CONCLUSION

Thanks to its new Intel Atom processor Z2580, the new Lenovo K900 smart phone delivered generally superior performance in our laboratory tests. It outperformed five industry-leading smart phones—the Apple iPhone 5, the Google Nexus 4, the HTC One, the Samsung Galaxy S III, and the Samsung Galaxy S4—on Web browsing benchmark tests, with wins of up to 82.7 percent.

These findings show that if you demand zippy performance from your smart phone, the Intel-powered Lenovo K900 can meet your Web-browsing needs.

APPENDIX A – THE DEVICES WE TESTED

Figure 8 presents the detailed specifications for the smart phones we tested.

	Lenovo K900	HTC One	Apple iPhone 5	Google Nexus 4	Samsung Galaxy S III (GT-I9305)	Samsung Galaxy S4 (GT-I9500)
Display resolution	1,920 x 1,080	1,920 x 1,080	1,136 x 640	1,280 x 768	1,280 x 720	1,920 x 1,080
CPU	Intel Atom Z2580 (CloverTrail+)	Qualcomm Snapdragon 600 Quad-core SoC	Apple A6 SoC	Qualcomm Snapdragon S4 Pro quad-core SoC	Samsung Exynos quad-core SoC	Samsung Exynos 5 Octa (octa-core) SoC
CPU frequency	1.8GHz (2.0GHz Turbo)	1,700 MHz	1,300 MHz	1,400 MHz	1,400 MHz	1,600 MHz 1,200 MHz
No. of cores	2	4	2	4	4	4 + 4
OS	Android 4.2.1	Android 4.1.2	iOS 6.1.4	Android 4.2.2	Android 4.1.2	Android 4.2.2
Memory (GB)	2	2	1	2	2	2
Storage (GB)	16	32	16	16	16	16
Battery capacity (mAh)	2,500	2,300	1,440	2,100	2,100	2,600
GPU	PowerVR SGX 544 MP2	Adreno 320	PowerVR SGX543MP3	Adreno 320	ARM Mali-400	Power VR SGX544MP3

Figure 8: Detailed specifications for the smart phones we tested.

APPENDIX B – TESTING METHODOLOGY

This appendix details the methodologies we followed in testing the smart phones.

MEASURING PERFORMANCE

Setting up the phones

1. Make sure the display will not automatically turn off during the test.
    a. For iOS devices:
        i. Go to Settings→General→Auto-Lock→Never.
    b. For Android devices:
        i. Go to Settings→Display→Sleep→30 minutes.
        ii. If the phone does not have a 30 minute option, install RedEye Sleep Toggle, and select the options as follows:
            - Enable at start
            - Enable when on AC
            - Awake Level: Fully awake

Measuring performance with WebKit SunSpider 0.9.1

Running the test

1. Open the default Web browser, and go to http://www.webkit.org/perf/sunspider/versions.html.
2. Select 0.9.1.
3. When the test completes, record the results.
4. Repeat steps 1 through 3 two more times.

Measuring performance with Google Octane v1

Running the test

1. Open the default Web browser, and go to https://developers.google.com/octane/.
2. Click Run it now.
3. Click Start Octane.
4. When the test completes, record the results.
5. Repeat steps 1 through 4 two more times.

Measuring performance with WebXPRT 2013

Running the test

1. Open the default Web browser, and go to http://www.principledtechnologies.com/benchmarkxprt/webxprt/.
2. Click Run WebXPRT 2013.
3. At the Ready to test your browser screen, click Continue.
4. Click Start.
5. When the test completes, record the results.
6. Repeat steps 1 through 5 two more times.

Measuring performance with MobileXPRT 2013 (Android devices only)

Note: This test does not run on the Apple iOS.

Setting up the test

1. Install MobileXPRT 2013.
    a. Under Security Settings, configure the test device to allow installation of apps from local storage (unknown sources).
    b. Copy the MobileXPRT2013CP.apk to /phone or /sdcard on the Android device.
    c. Double-click the APK. Note: If the test device does not have a default file explorer, you may need to install a file explorer application. You can also use Android Debug Bridge (ADB) to copy and install MobileXPRT by connecting the test device to a PC.
    d. Click Install to begin the installation.
    e. After the installation is complete, click Open.
    f. MobileXPRT will then prompt to install the UX Tests component. Click Install.
2. After installation of the UX Tests is complete, click Done. MobileXPRT will then copy the workload data files to required folders.
3. Once the workload data files are copied, setup is complete.

Running the test

1. Launch MobileXPRT 2013 by pressing the MobileXPRT icon.
2. Press All Tests.
3. When the test completes, record the results.
4. Repeat steps 1 through 3 two more times.

MEASURING THE LAUNCH TIME OF GAMES

Note: These tests require the use of a stopwatch.

Setting up the test

1. Purchase and install the following games:
    - Asphalt 7: Heat
    - Epic Citadel

Running the test

1. Simultaneously launch the game and start the stopwatch.
2. When the game finishes loading (as indicated by the following items appearing on screen), stop the stopwatch.
    - Asphalt 7: Heat – the words “Touch the Screen to Continue”
    - Epic Citadel – the words “Tap to Start”
3. Record the results.
4. Repeat steps 1 through 3 two more times, for each game.

NOTING DISPLAY AND CAMERA SPECIFICATIONS

1. Note each phone’s display resolution.
2. Note each phone’s front-facing camera resolution.
3. Note each phone’s rear-facing camera resolution.

4. Note each phone's rear-facing camera f-stop.
5. List each phone's rear-facing camera features.

Determining the phone's camera shots per second and maximum shots features

1. On a separate notebook computer, install the online stopwatch tool from http://www.online-stopwatch.com/.
2. Set each phone's camera to continuous or burst mode (depending on the phone).
3. Start the online stopwatch tool on the separate notebook computer.
4. Press and hold the camera shutter button and take as many pictures as is allowed.
5. View the pictures and count the number of pictures that were taken a second.
6. Count the number of pictures taken to determine the maximum number of shots that were taken continuously.

APPENDIX C – WEB BROWSER BENCHMARKS

WebKit SunSpider 0.9.1

SunSpider is a benchmark that tests JavaScript performance on Web browsers. Its focus is on real-world applications (i.e., text manipulation and encryption) instead of "microbenchmarks." Because the JavaScript programming language is essentially the backbone of interactive portion of modern Web pages, it is important to test how effectively each phone's Web browser runs it. We used version 0.9.1. To learn more about SunSpider, visit www.webkit.org/perf/sunspider/sunspider.html.

WebXPRT 2013

WebXPRT 2013 uses scenarios created to mirror the tasks you do every day to compare the performance of almost any Web-enabled device. It contains four HTML5- and JavaScript-based workloads: Photo Effects, Face Detect, Stocks Dashboard, and Offline Notes.

WebXPRT runs on a wide variety of devices and operating systems—from iPad tablets to Android phones to Windows computers. WebXPRT is available to the public and runs right from your browser.

To learn more about WebXPRT 2013, visit www.webxprt.com

MobileXPRT 2013

MobileXPRT, the newest member of the XPRT family, evaluates smart phone performance and provides a fair and consistent basis for comparing the growing range of devices on the market.

This benchmark is based on real-world scenarios and provides user-relevant metrics and results. The first operating system it supports is Android, but the intent is to support additional operating systems in the future.

At the time of our testing, the latest version of MobileXPRT was a community preview, MobileXPRT 2013 CP. Community previews are available to members of the BenchmarkXPRT Development Community, and allow publication of results. For information about the latest version of MobileXPRT, go to http://www.mobilexprt.com.

Google Octane v1

Google Octane is a modern benchmark that measures a JavaScript engine's performance by running a suite of tests representative of today's complex and demanding Web applications. Octane's goal is to measure the performance of JavaScript code found in large, real-world Web applications.

To learn more about WebXPRT 2013, visit developers.google.com/octane/

APPENDIX D – CAMERA FEATURES

Figure 9 provides details about the cameras in each of the phones we tested.

	Lenovo K900	Apple iPhone 5	Google)Nexus 4	HTC One	Samsung Galaxy S III	Samsung Galaxy S4
Focus mode	Auto, Continuous				Auto Focus, Macro, Face Detection	Auto Focus, Face Detection
Exposure	-5, -4, -3, -2, -1, 0, +1, +2, +3, +4, +5		-2, -1, 0, +1, +2			
Timer	3sec, 5sec, 10sec			2sec, 5sec, 10sec	2sec, 5sec, 10sec	2sec, 5sec, 10sec
Shooting mode	Burst Mode, Panorama, Night Portrait, HDR Backlight, Weak light, Smiling Faces, Macro	Normal, HDR, Panorama	Normal, Portrait, Landscape, HDR, Photo-sphere (360 degree shot), Panoramic	Normal, Portrait, Landscape, Backlight, Text, Macro, Night, HDR, Sweep panorama	Single Shot, Burst Shot, HDR, Smile shot, Beauty, Panorama, Cartoon, Share Shot, Buddy Photo Share	Night, Auto, Beauty face, Best face, Sound&Shot, Rich tone(HDR), Drama, Animated photo, Eraser, Panorama, Sports
Scene mode	Normal, Night scene, Portrait, Landscape, Motion, Firework		Auto, Action, Night, Sunset, Party		Portrait, Landscape, Night, Sports, Party/ Indoor, Beach/Snow, Sunset, Dawn, Fall color, Firework, Text, Candlelight and Backlight	Night, Sports
Continuous shooting mode	Continuous and Burst mode			Continuous on/off, Limit to 20 frames on/off, Auto review on/off		
Picture size	13M pixels, 9M pixels, 8M pixels, 6M pixels, 5M pixels, 3M pixels, 1080p		8M pixels, 5M pixels, 3M pixels, 2M pixels, 1.3M pixels, VGA, QVGA			

	Lenovo K900	Apple iPhone 5	Google)Nexus 4	HTC One	Samsung Galaxy S III	Samsung Galaxy S4
Effects	Tilt-Shift, Background Blur, Kaleidoscope, Mirroring, Background Flash, Fish-eye, Glass tears, Heat signature, Pencil, Asterism, Water, Cartoon, LOMO, Country, Poster, Pop, Color, IR, High Contrast, Anti, Old time, Natural, Black and white, Lens Flare			Normal, Distortion, Vignette, Depth of Field, Dots, Mono, Country, Vintage, Vintage Warm, Vintage Cold, Grayscale, Sepia, Negative, Solarize, Posterize, Aqua	Negative, Black and white, and Sepia	No Effect (None), Sepia, Gray-scale, Vintage, Vignette, Faded color, Tint, Cartoon, Moody, Rugged, Oil pastel, Fisheye
White balance	Auto, Incandescent light, Sun light, Florescent light, Cloudy		Auto, Incandescent, Daylight, Fluorescent, Cloudy	Auto, Incandescent, Fluorescent, Daylight, Cloudy	Auto, Daylight, Cloudy, Incandescent and Fluorescent	Auto, Daylight, Cloudy, Incandescent and Fluorescent
Additional features	**ISO settings:** Auto, 100, 200, 400, 800 **Effect adjust:** Default, Brightness, Contrast, Saturation, Sharpness **Other Camera options:** GPS location, Stereoscopic, Touch control shot, Switch CCD camera (rear or front), Flash mode, Image quality, Composition guide **Extensions:** Passers-by		Not in camera, but in Gallery app you can apply-- Effect (Artistic Filters): None, Punch, Vintage, B/W, Bleach, Instant, Latte, Blue, Litho, X Process Frames (Borders): Crop (Transforms): Manual, 1:1, 4:3, 3:4, 5:7, straighten, rotate, flip, mirror Post-process: Autocolor, Exposure,	**Crop:** Wide, Regular, Square **Camera options:** Face detection, Auto smile capture, Geo-tag photos **ISO settings:** Auto, 100, 200, 400, 800, 1600		

	Lenovo K900	Apple iPhone 5	Google)Nexus 4	HTC One	Samsung Galaxy S III	Samsung Galaxy S4
	(Clear pedestrians or moving objects in the picture after shooting), Smart Group (Selection of the best expressions after taking group photos), GIF creator, Magic GIF creator		Vignette, Contrast, Shadows, Vibrance, Sharpness, Curves, Hue, Saturation, BW Filter			

Figure 9: Camera features of the smart phones.

ABOUT PRINCIPLED TECHNOLOGIES

Principled Technologies, Inc.
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We provide industry-leading technology assessment and fact-based marketing services. We bring to every assignment extensive experience with and expertise in all aspects of technology testing and analysis, from researching new technologies, to developing new methodologies, to testing with existing and new tools.

When the assessment is complete, we know how to present the results to a broad range of target audiences. We provide our clients with the materials they need, from market-focused data to use in their own collateral to custom sales aids, such as test reports, performance assessments, and white papers. Every document reflects the results of our trusted independent analysis.

We provide customized services that focus on our clients' individual requirements. Whether the technology involves hardware, software, Web sites, or services, we offer the experience, expertise, and tools to help our clients assess how it will fare against its competition, its performance, its market readiness, and its quality and reliability.

Our founders, Mark L. Van Name and Bill Catchings, have worked together in technology assessment for over 20 years. As journalists, they published over a thousand articles on a wide array of technology subjects. They created and led the Ziff-Davis Benchmark Operation, which developed such industry-standard benchmarks as Ziff Davis Media's Winstone and WebBench. They founded and led eTesting Labs, and after the acquisition of that company by Lionbridge Technologies were the head and CTO of VeriTest.