



TRANSFORMING ANDROID

Technical Report | November 2009

5 Steps to Elevating the Android Experience

Introduction

The Android race has begun. According to Gartner, Android could well be on its way to the second highest market share of mobile operating systems by 2012.

The sheer market power of Google, the attractiveness of the platform's open environment for developers, an expanding number of connected consumer electronics, and an estimated 40 Android-based handsets planned for shipping in 2010 are all creating significant momentum for the technology.

Android has already captured 6% market share of smartphone Operating System (OS) market in the US, according to the 2009 AdMob Mobile Metrics Report. This leaves it tied with Palm as the fourth largest smartphone OS behind iPhone, RIM, and Windows Mobile.

In the initial months following the launch in the US, Android requests increased an average of 47% per month, clearly underlining Android's increasing dominance as a Linux-based Open Source mobile phone OS.

Beyond mobile devices, Android is getting designed into devices that extend far beyond the phone, and is expected to become a key ingredient in products aimed at the \$700B global consumer electronics market such as digital picture frames (DPFs), mobile internet devices (MIDs) and more.

The challenge, however, for commercializing devices based on this new platform, is creating a customer experience comparable with more mature technologies and closed systems.

As with any new OS platform, certain challenges must be overcome to create a competitive user experience. These 'experience gaps' include:

- Creating an innovative device and user interface (UI) design;
- Eliminating processor dependencies;
- Ensuring robust multimedia middleware;
- Integrating rich multimedia applications;
- Leveraging cloud services;
- Performing exhaustive interoperability and certification testing.

Those who solve these challenges quickly will have a significant competitive advantage in the race for hundreds of billions of dollars and devices spawned by Android.

Aricent has launched a comprehensive Android consultancy and lifecycle services practice that offers new Android-Optimized middleware and application suites combined with specialized innovation design, consulting and comprehensive lifecycle services, while improving power efficiencies and reducing development costs and complexity.

As leaders in the mobile software space, Aricent is working with a number of customers across the entire ecosystem (chipset vendors, device manufacturers, application vendors to service providers) to commercialize the Android platform.

In this technical report, we will explore various aspects of solution development on Android and highlight five essential steps to transforming user experiences on Android.

Gartner®

"....Android will be second with nearly 76 million units sold and 14.5% market share by the end of 2012"

frog design™

"Android itself is not a differentiator, but a key building block for companies trying to ignite user passion comparable to what we saw with the iPhone"

Mark Rolston - Chief Creative Officer of frog design, Aricent's global innovation arm

5 Steps to Elevating the Android Experience

Step 1 – Design Innovative Devices and UIs

Innovative user experiences are now table stakes for an increasingly sophisticated global mobile subscriber base. The user interface (UI) must be simple and intuitive - stylized based on individual preferences - and must provide an aesthetic look and feel for menus, icons and navigation elements. Beyond the device design and UI, a number of other elements like ubiquitous wireless connectivity, connectedness to other devices in the “home” ecosystem, performance optimization of chipsets, CODECs etc. and a highly optimized multimedia sub-system all needs to be harmonized to adequately address the exponentially growing user expectations on innovation and usability.

And finally, users are also demanding seamlessness including cross-platform consistency in experiences as they transition between the home, car and work environments.



Unlike most of the other Linux based mobile phone software platforms, Android has a complete set of Application Programmable Interfaces (APIs) available for a comprehensive line of functionalities - from user interface to power management, that is a big step to designing compelling user experiences. All Android applications are attributed “equal” priority, meaning there is no distinction between native applications and user developed applications. This non-preferentiality allows for more innovative applications, from an active community of application developers, than are currently available on other platforms. Android has also implemented low-level APIs that can directly access the underlying hardware – e.g. Wi-Fi or Bluetooth physical layers, providing more flexibility. Additionally, Android allows extending the hardware on handsets post commercialization – e.g. it is possible to add support for a Bluetooth profile that was not integrated in the handset originally.

Given the open source nature of the Android operating system, it is extremely challenging to maintain a high level of consistency in user experiences across multiple device platforms. Developers are free to choose the look and feel, aesthetics and often, the functional behavior for their applications. From a device ODM’s perspective, maintaining a consistent relationship between the design of individual applications and the underlying platform is important. In addition, to ensure seamlessness for end-users across devices and environments, consistency in design is the key. And hence, the implications of an unregulated applications development framework must be addressed.

For device ODMs and CE manufacturers, delivering compelling user experiences require a detailed consultative audit and benchmarking of UI designs to ensure they harness the latest innovations and technologies, and align well with customers' business objectives. These include for example simplifying content discovery to increase data usage, creating more value through customization and personalization, and ensuring a consistent and coherent branded experience. In addition, the tradeoffs in terms of rich application enablement and battery life, processor speeds and support of enhanced multimedia enablers must also be recognized.

Elevating the Android Experience Step 1

Design Innovative Devices and UIs

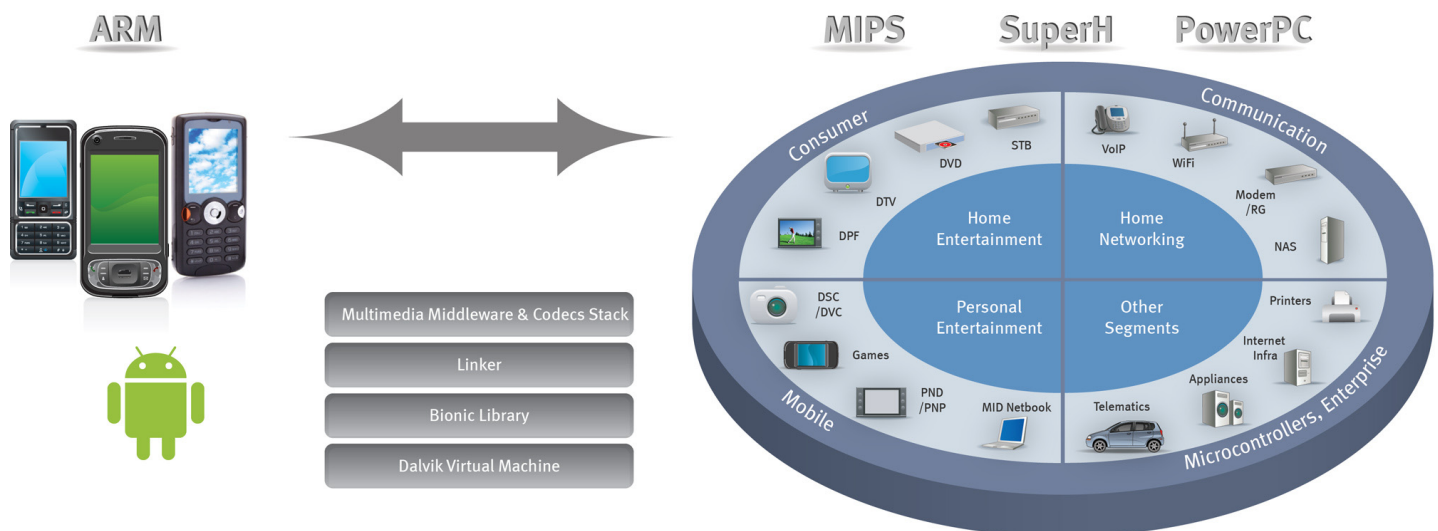
- Design an innovative device
- Create an intuitive user interface
- Ensure cross-platform experience consistency

Step 2 – Solve Multi-processor, Power and Performance Challenges

Android's low-cost licensing model, "openness" of capabilities and access, and support for cloud services has seen a lot of early adopters such as Motorola, Samsung, T-Mobile, Vodafone and others for mobile devices. However, there is a growing adoption in the OEM community beyond mobile handsets and spreading out to Personal Multimedia and Mobile Internet Devices, Digital Video and Home Entertainment (STB / DTV / HDTV), Automotive (GPS and Infotainment), Medical Equipment, Home Automation, SOHO Networking, Instrumentation and Industrial control.

Multi-processor Support – The Android mobile phone stack was originally designed targeting the ARM processor technology. While the ARM architecture was acceptable early on with many mobile devices adhering to this architecture, it is now essential to scale and repurpose Android for other processor technologies such as MIPS, SuperH, PowerPC and Atom if there needs to be a strong play in the growing CE industry. This would require porting of Android on these targets, and device ODMs need to develop this expertise in-house or partner with an industry expert that offers porting as a core competency.

Supporting Android on a new processor technology typically requires porting of the Android Dalvik Virtual Machine and optimizing it for the target CPU core, adapting Android's non-standard Bionic Library, Linker and other Software Infrastructure for the target platform along with optimization of CODECs and multimedia middleware for the target processor. It is evident that making Android work on a non-ARM based CPU core is non-trivial and requires expert understanding of the processor technology, the Linux 2.6 Kernel and the Android software stack.



Maximizing Power Efficiency – As user experiences based on Android are extended to other devices and platforms, power management will be crucial. For small devices, optimal power management is essential to avoid reduced battery life and sluggish performance. Android’s Power Management implementation is entirely based on the Linux Power Management principles which can be improved to deliver a highly efficient product.

Performance Optimization – With more moving parts and complexity today than ever before that need to be harmonized, including chipsets, power supplies, multiple radios, displays, CODECs and more - performance optimization is mandated. For device ODMs and CE manufacturers that are developing solutions on the Android platform, limitations in achieving optimal performance through usage of open source components must be understood. Special attention needs to be attributed to Android’s PacketVideo (PV) OpenCORE Multimedia Framework, the fundamental enabler for multimedia experiences and benchmarked against desired performance metrics such as frames/sec, frame dropout rates, etc.

Elevating the Android Experience **Step 2**

Solve multi-processor, power and performance challenges

- Expand Android support to non-ARM based processors
- Improve Linux power management limitations
- Optimize device architecture and ecosystem components

Step 3 – Integrate Rich Multimedia Middleware and Applications

“Design Realization” beyond “Design Think” is achievable only when the optimal set of enablers is available. For the next-generation devices, this would include selecting middleware that supports rich multimedia capabilities like HD, complemented with developing a comprehensive suite of rich multimedia and communication applications.

With the explosion of new connected devices like Smartphones, MIDs, Netbooks and Consumer Appliances, and a variety of new applications, the demand for enhanced multimedia experiences is on the rise. HD Video is increasingly being sought even as screen sizes continue to shrink. Power budgets on devices are shrinking even as the demand for power-intensive multimedia applications is on the rise. Boundary conditions are thus evolving every day.



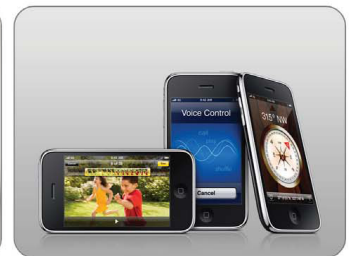
Intel® Retail Proof-of-Concept



Next gen kiosk



Photo printer



iPhone

With Android’s overwhelming acceptance in the mobile devices space and new CE devices on Android already being announced, an enriched multimedia experience with HD content will be table-stakes to ensure competitiveness.

The key fundamental multimedia enablers must be optimized and pre-integrated with target Android platforms to deliver the best performance, including:

- **Multimedia CODECs** - Audio, Video, Image and Speech CODECs, including HD
- **Device Middleware/System Plugins** - Pre-packaged software and frameworks for easy integration with target hardware platforms
- **Rich Multimedia Applications** (e.g. Media Player, Media Recorder and many more) - comprehensive set of players and recorders for multimedia content
- **Communications Applications** (e.g. VVoIP for WiMAX and LTE, RCS and many more) - portfolio of Voice over IP services and rich communications using SIP/ IMS

That being said, so far, the Android PV OpenCORE Multimedia framework does not include HD Video support. In fact, achieving high picture quality up to 720p and high performance levels of 30 fps (frames per second) is a major industry challenge. While CODECs like Xvid, DivX have emerged primarily in response to demand for high quality resolutions, the challenge of achieving an overall system performance of 30 fps at these high resolution levels is daunting.

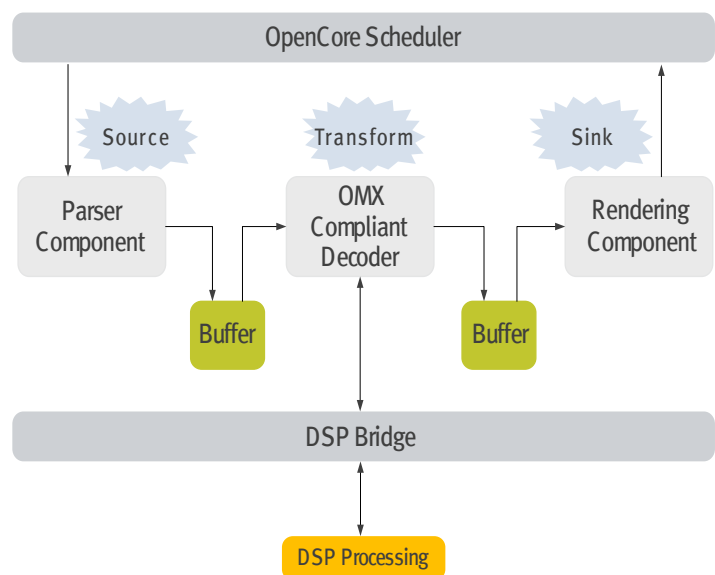
Additional gaps exist in the lack of professional grade Image Processing capabilities (algorithms, special effects etc.) in Android. High quality image and video processing has become an integral part in many CE devices, and drives premium pricing. More often than not, software vendors resort to more powerful hardware or spend significant resources on code optimization to attain desired performance levels. Others merely compromise on the image quality levels.

Buffer management is another potential source of bottleneck in the Android OpenCORE Framework and needs to be addressed. Any multimedia system has three fundamental design elements –

- Data Source (responsible for fetching the data either from a file or over network or capturing the raw data from a camera driver)
- Data Transform (encode/decode functionality)
- Data Sink (responsible for rendering the Audio and Video to the user)

The diagram depicts the current Android PV OpenCORE implementation for the TI OMAP 3430 ARM / DSP dual core processor. In the OMAP architecture, the ARM and the DSP communicates over a DSP Bridge Software using Shared Memory IPC.

Synchronization problems have been observed for mismatches in the decoding speed (at the Data Transform) and the rate at which the data is being sent (at the Data Source). If the shared



buffer is full, then the Date Source waits for further notification from the PV OpenCORE framework before transmitting any data - the symptoms for a major performance bottleneck.

In order for device ODMs and CE manufacturers to drive a differentiated user experience, these aspects need to be addressed.

Step 4 – Leverage the Power of the “Cloud” in Applications Development

With the arrival of Android, mobile application development has experienced a tipping point. Over the years, mobile users have demand more choices, more opportunities to personalize their phones, with added functionalities. With diminishing revenues from Voice, service providers are striving to provide value-added content to their subscribers through innovative business models. Software vendors and an ever growing community of mobile developers are demanding the flexibility and tools to develop the powerful applications with minimal platform roadblocks. Recent explosion in social networking and other forms of collaboration has fuelled this further.

And finally, major device ODMs’ are seeking a stable and affordable platform to build a unique and differentiate portfolio of devices, to counter the “iPhone” phenomenon. Up until now, no single mobile platform has adequately addressed the challenges for all the ecosystem players.

New emerging trends are also shaping the destiny of the next-generation application development. One of the biggest areas of promise for innovation and disruption in the communications industry is the convergence of cloud services with global consumer mobile communications networks. Network operators are developing APIs to offer Cloud Service Providers a single point of access to their network capabilities and global customer base. This form of convergence is likely to drive a surge in mobile Internet innovation, and improved subscriber experience overall.



Elevating the Android Experience Step 3

Integrate rich multimedia middleware and applications

- Solve open source multimedia software performance limitations
- Integrate rich multimedia applications like media players, recorders, voice and video conferencing etc.
- Enable advanced applications including HD and professional grade image processing

BusinessWeek

“These days, however, decent hardware is simply a starting point; the real competition among smartphones is in software”

Stephen H. Wildstrom
Technology and You Columnist

As an innovative and open platform offering the maximum levels of flexibility, Android can be a potential game-changer for the mobile development community by addressing these growing needs and trends in the marketplace.

While the openness of Android is a boon in many ways, there are aspects of application development on Android that needs to be recognized and addressed by device ODMs.

Android is a moving target and with each major release, SDKs and APIs are constantly being modified to support new features and fix defects from earlier releases. Moreover, there are scores of new Android handsets being launched by HTC, Samsung, Motorola, Verizon, Dell, Sony Ericsson and others, each with a different version of Android. This will pose a significant integration challenge for software developers as the same application may not work across all phone models and will require maintaining phone model specific application versions, which is a developer's nightmare.

Another related issue is the current Apache 2.0 Licensing model of Android. Under this model, the device manufacturers have the flexibility to change all or some of the software libraries to develop their own custom version of Android. This is another scenario where third party applications / middleware solutions may face serious challenges in trying to accommodate such customizations.

In Android, all third party applications must be written for the native virtual machine called Dalvik VM. What this essentially implies is that non-Dalvik libraries, and hence applications based off them, cannot be deployed on Android handsets. For example, a user can replace his current web browser on Android as long as the new browser complies with the underlying WebKit engine. But to integrate, say a Mozilla based browser that uses the Gecko engine, would require a complete Dalvik overhaul of Gecko which is not a trivial task.

Other gaps exist in the support and integration of core applications such as Telephony which has always been an issue on any Mobile OS platform as it entails integrating and adapting modems to enable voice, data calls and other network related functions. But the real challenge comes when modems from different vendors, each supporting a different set of AT commands, needs to be adapted and integrated with Android's Telephony Manager.

For software vendors and ODMs aspiring to develop next-generation applications on the Android platform, these considerations need to be addressed.

Elevating the Android Experience **Step 4**

Leverage the power of the cloud for applications development

- Implement multiple levels of abstraction to cope with Android evolution
- Proactively develop a network API strategy to address the needs for providing differentiated experiences for each service provider
- Consider strategic partnerships to address expertise gaps in a rapidly evolving ecosystem

Step 5 – Implement a Comprehensive Product Assurance Strategy

The advent of new connected devices and next-generation applications is driving vendors to rethink their complete testing methodology, which till late included feature and functional testing and certifying the device on a network in different geographies. Vendors now need to perform a comprehensive UI audit to provide more value through customization and personalization, and for ensuring a consistent and coherent branded experience.

A number of Android smartphones have been launched, some more are about to be launched and yet some more have already been announced – all with a commonality in their support of multiple wireless access capabilities i.e. Wi-Fi, 2G / 2.5G / EDGE, 3G and Bluetooth, leading to a manifold increase in the complexities of interoperability.

Another key challenge is to ensure that existing products and new services are interoperable, given the constantly changing technological landscape. This complexity is further compounded by the presence of equipment from a multitude of vendors, as well as the exponential growth in operator networks. Hence, extensive Interoperability Testing (IOT) becomes a key gating factor prior to a Droid launch.

Further, testing and validation of the various hardware and software components, including review of key user experience characteristics such as audio and video performance, security, power consumption and more has become essential. The ODMs must also ensure interoperability with the myriad of global wireless communication networks in place today. This complexity, if not understood early in the lifecycle process, has prevented many innovative concepts from ever being realized. In fact, end to end (E2E) testing covering multiple sub-systems and often, the entire network is more and more becoming the norm and needs to be complemented by a comprehensive set of lifecycle services.

Typically, the following aspects are assured through IOT -

- Protocol stack compliance per the standards, including various network configurations and anomalies
- Stability of the mobile device under stress testing
- Effectiveness of the device in handling network related errors
- Performance under varied radio conditions (throughput, reaction time, roundtrip delays)
- Backward and forward compatibility

Assurance on each of these areas is a complex and demanding process requiring overall systems expertise, effective integration of test results and experience in Quality Assurance (QA) methodologies. To ensure complete interoperability, the devices must be tested on all the network interfaces with various network elements in a live environment. For the service providers, this is an expensive proposition as the costs associated with a variety of test equipment are high. Additionally, with increasingly shorter time to launches, correct planning and flawless execution is imperative, failing which the expenses further escalate.

Summary

Android is a true game-changer for the mobile space, more effectively addressing the two fundamental shifts in consumer electronics - all things connected, and exponential growth in consumer expectations on innovation and improved usability. This is the era of open operating systems and the growing market adoption of the Android OS on multiple devices and the emergence of an ecosystem of active application vendors creating new, innovative solutions clearly underline the trend.

In order to deliver highly differentiated Android based offerings, there is a clear need to address the “experience gaps”. In this technical report, we have outlined 5 key Steps to Elevating the Android Experience – areas that device ODMs, CE Manufacturers and Service Providers need to address in order to deliver compelling end user experiences on Android.

Elevating the Android Experience **Step 5**

Implement a comprehensive product assurance strategy

- Execute product testing beyond a single application or sub-subsystem
- Perform extensive interoperability and end-to-end testing
- Develop processes for future evolution and enhancements



Mark Wodopian
VP & GM

“Aricent’s leadership in System Integration, along with the capability to port their feature-rich, best-in-class solution on any operating system, made them a clear choice for Multimedia frameworks as we expand the third party software offerings for our Ultra Low Power Processor Platform on Android”

At Aricent's Android Center of Excellence, our specialists are pro-actively evolving these 5 steps and identifying other areas of improvements and are working closely with several ODMs, Service Providers and Application Developers to address them.

5 Steps To Elevate The Android Experience	Aricent's Android CoE Advantages
Step 1: Design Innovative Devices and UIs <ul style="list-style-type: none"> Design an innovative device Create an intuitive user interface Ensure cross-platform experience consistency 	<ul style="list-style-type: none"> Best-in-class device and UI innovation and design Proven expertise in cross platform user experiences Comprehensive consulting services from audit, strategy, and assurance to optimization
Step 2: Solve Multi-processor, Power and Performance Challenges <ul style="list-style-type: none"> Expand Android support to non-ARM based processors Improve Linux power management limitations Optimize device architecture and ecosystem components 	<ul style="list-style-type: none"> Porting of Android Core to multiple processor technologies Comprehensive lifecycle services and experience on Linux BSP and device drivers
Step 3: Integrate Rich Multimedia Middleware and Applications <ul style="list-style-type: none"> Solve open source multimedia software performance limitations Integrate rich multimedia applications like media players, recorders, voice and video conferencing etc. Enable advanced applications including HD and professional grade image processing 	<ul style="list-style-type: none"> Aricent is one of the first to provide 720p, 30fps solution for HD Video Aricent's Media EXP framework is available for Android, and includes advanced CODECs and Image Processing algorithms that are pre-optimized for several processor technologies
Step 4: Leverage the Power of the Cloud for Applications Development <ul style="list-style-type: none"> Implement multiple levels of abstraction to cope with Android evolution Proactively develop a network API strategy to address the needs for providing differentiated experiences by each service provider Consider strategic partnerships to address expertise gaps in a rapidly evolving ecosystem 	<ul style="list-style-type: none"> Aricent's MCIL (Media Controller Interface Layer) –abstracts applications from changes in Android APIs/SDKs Aricent provides integration services for modem basebands with Android's Telephony Layer
Step 5: Implement a Comprehensive Product Assurance Strategy <ul style="list-style-type: none"> Execute product testing beyond a single application or sub-subsystem Perform extensive interoperability and end-to-end testing Develop processes for future evolution and enhancements 	<ul style="list-style-type: none"> Aricent offers extensive software and hardware tools for end-to-end compliance and managed testing Aricent delivers IOT on live operator-like-networks Aricent has a repository of over 70,000 test cases, more than 200 Network Elements and over 100 pieces of test equipment from leading OEMs

About Aricent

Aricent is a global innovation, technology and services company focused exclusively on communications. Aricent combines the leading innovation capabilities of frog design with unparalleled domain expertise in communications as a strategic supplier to the world's foremost infrastructure, application and service providers. The company's investors include Kohlberg Kravis Roberts & Co., Sequoia Capital, The Family Office and The Canadian Pension Plan Investment Board.

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