

# Hardware Diagnostics



for

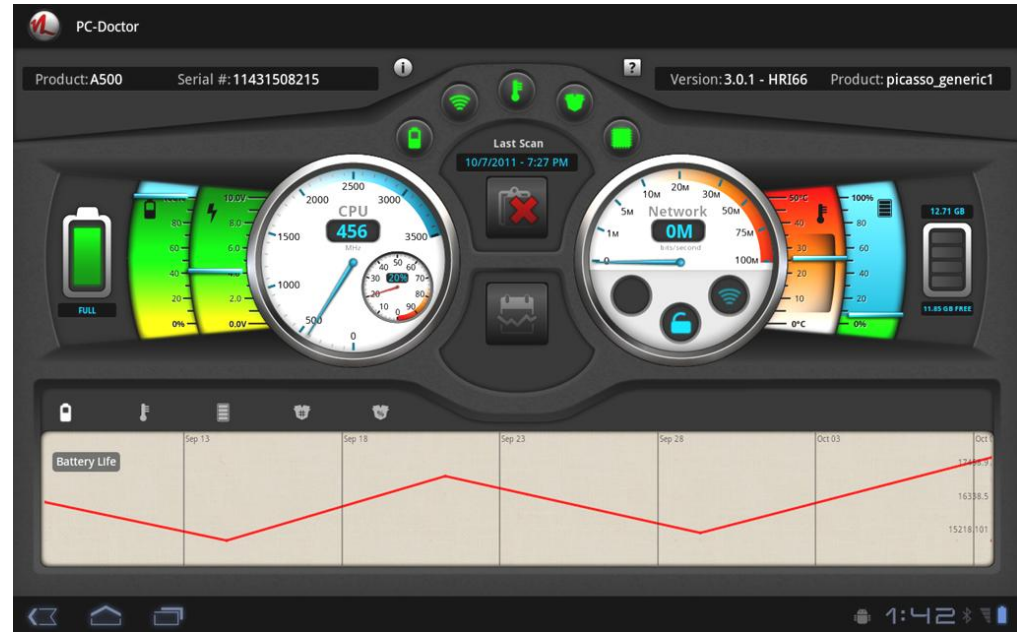
## Android Platforms

February 2012

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# Agenda

- Part 1 – Why Diagnostics?
- Part 2 – Diagnostic Experiences
- Part 3 – Telemetry Analysis



- Frequently used terms
  - NTF = No Trouble Found (aka No Defect Found, Can Not Duplicate, etc.)
  - 🤖 = Android

# Part 1 – Why Diagnostics?

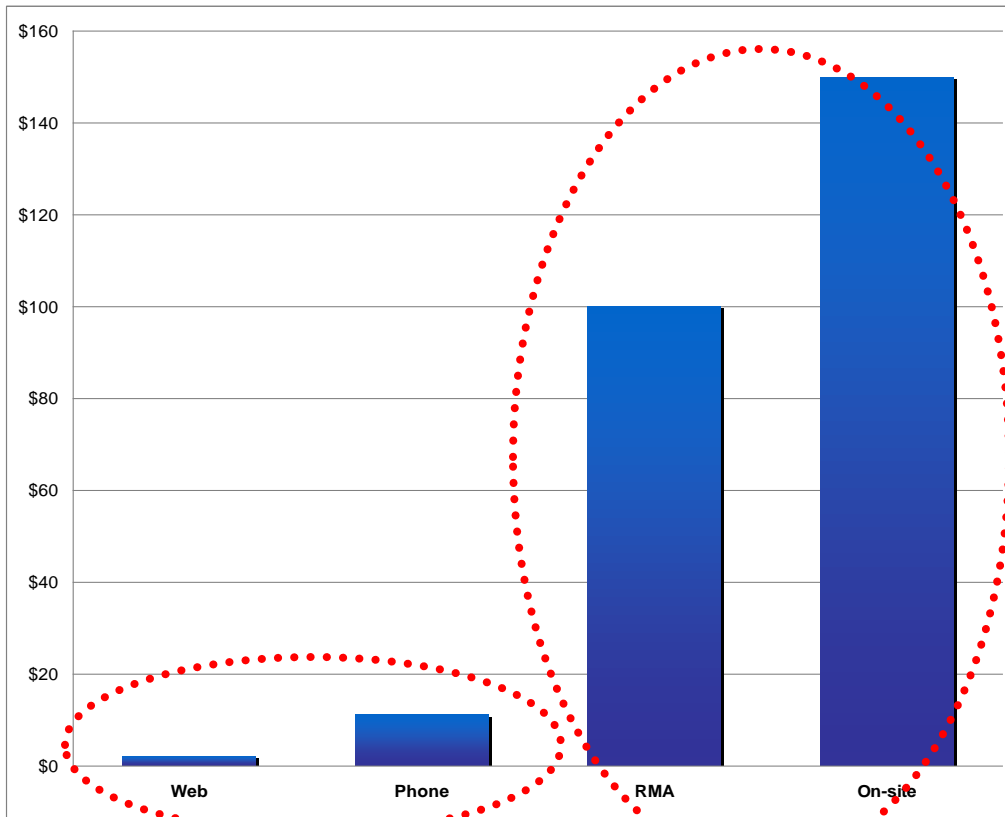
- No Trouble Found (NTF)
  - Cost of processing a PC return \$100 or more
- *"70% of  devices are returned because of faulty applications"*
  - Sanjay Jha, Motorola CEO, June 2011
- *"14% of technical support calls on  relate to hardware"*
  - WDS "Controlling the Android", October 2011 (<http://bit.ly/wdsandroid>)
- *"1% reduction in ... [NTF] will reduce return and repair costs by 4%"*
  - Accenture "Reducing the Quantity and Cost of Product Returns in Consumer Electronics", September 2011 (<http://bit.ly/accenturentf>)
- **Need to exonerate the hardware**



# Best Place For Diagnostic Tools



Cost of a warranty support event



- Duh 1: Empower users with preloaded tools

- Duh 2: Stamp out repeat returns with service tools
- Goal: handle the 86% of non-HW issues without product returns




# Why Not Just Experts? (aka Longbow vs. Guns)

- Longbow vs. guns (before rifling)
  - Rate of fire: 10 vs. 1-3 rpm (later up to 4)
  - Effective range: 400 vs. 50-100 m
  - All weather vs. club in wet conditions
- Why did the gun replace the English longbow?
- Answer: Time to train a soldier
  - Longbow: training must begin at childhood
  - Guns: 2-3 months
- Analogy to Diagnostics:
  - Expert can match a diagnostic program, but...
  - Diagnostics can make a junior technician as effective as an expert





# Android Support Challenges



- Entire support chain struggling with platform
- New combination of warranty cost drivers
  - New users with new platform in new form factor
  - New application distribution model
  - Time-to-market vs. supportability
-  has limitations to its supportability
- Volumes are only going up
  -  tablets have 39% market share in 4Q 2011 (10.5M units)
    - Strategy Analytics (<http://bit.ly/sa4q11tablets>)
  - Smartphones to grow to 42% of 1.8B unit market (half , i.e. 378M++)
    - HIS "*Smartphones and 4G, Changing the Mobile Industry*" (<http://bit.ly/ihs2q11>)

# Isn't Android kind of like a PC?



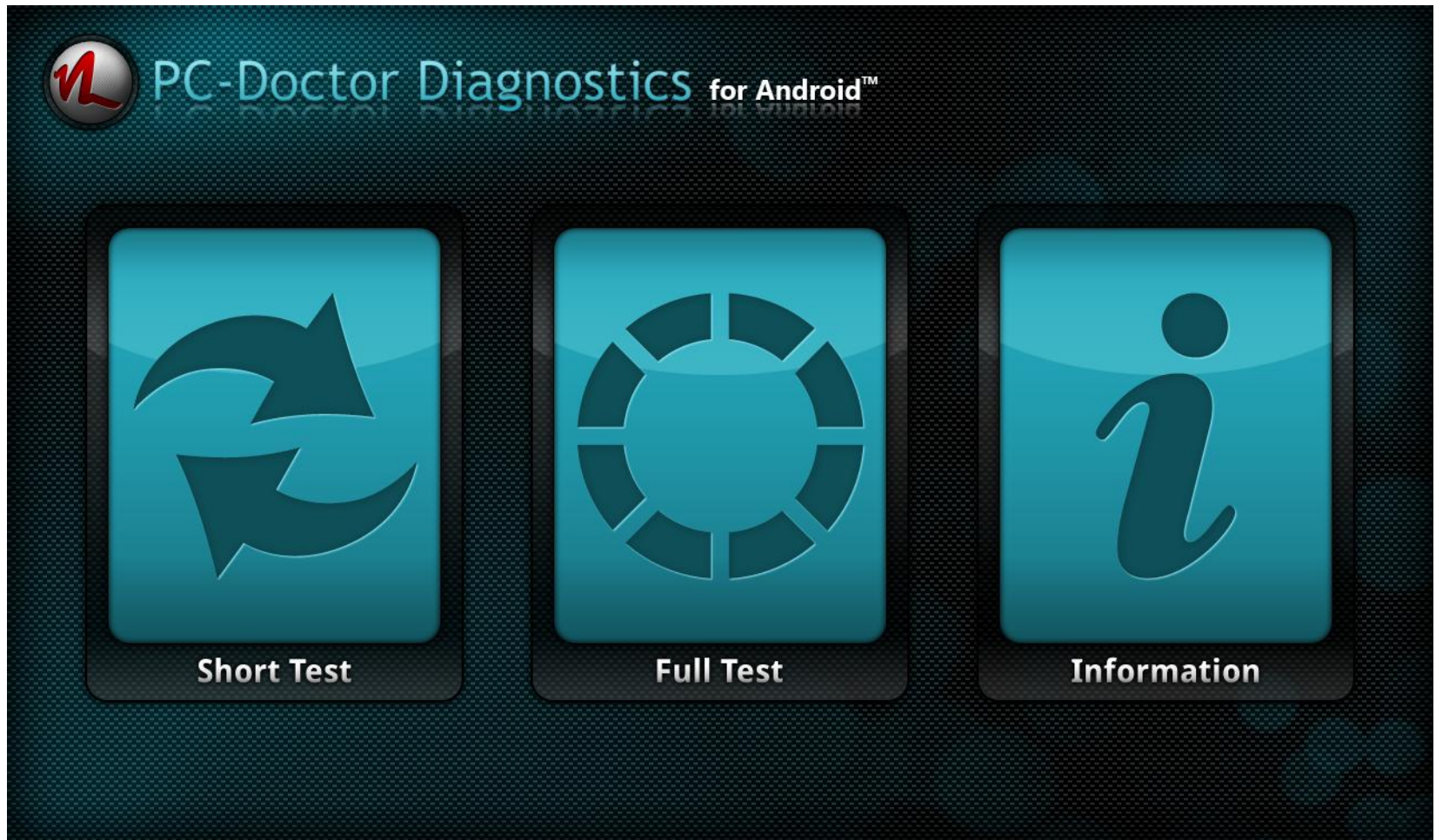
- Not when diagnosing the system
  - Hardware diagnostics is easy – making it available is not
- Windows applications get low level access to system  
vs.  
 applications run in a sand box
- Windows users can define security policy  
vs.  
 Google, OEM, ODM, and carriers define what users can do

# Then isn't Android like a cell phone?




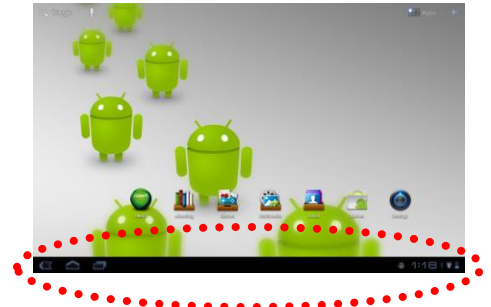
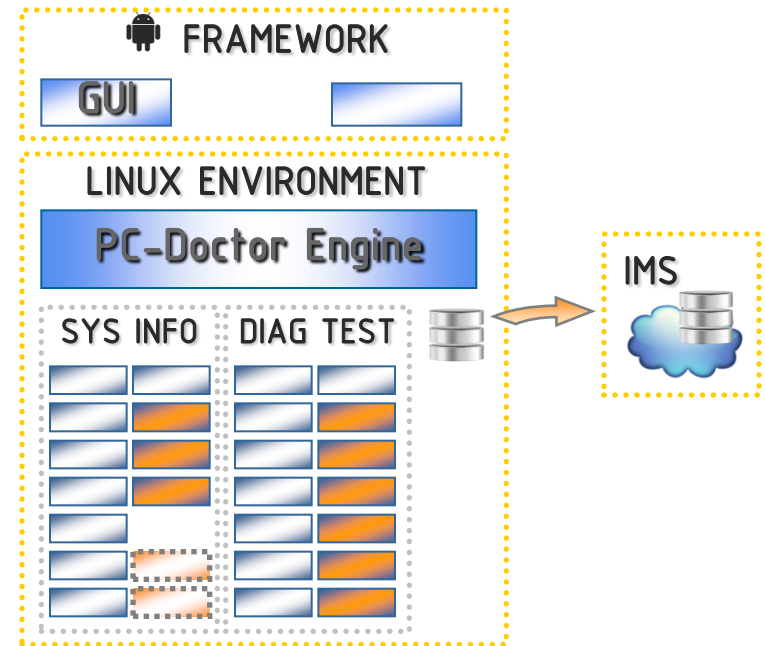
- Carriers probably wish it were
  - Swap-support model is easy to manage
- ☎ store relatively little state information  
vs.  
• 🤖 get heavy with user data
- ☎ locked down application packages  
vs.  
• 🤖 Market, Amazon Appstore, ...
- ☎ users accept product replacement for support  
vs.  
• 🤖 users hope/expect/demand “their” device back

# Part 2 – Android hardware diagnostics experiences



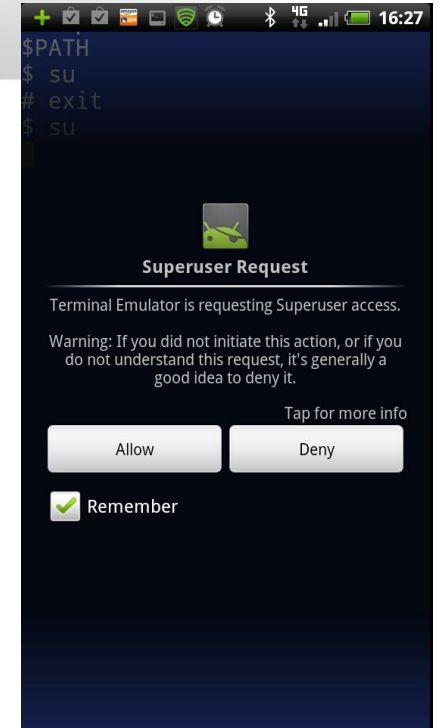
# 0 to 100% in 6 months

- PLAN A: our engine/UI plus ODM diags
  -  ODM diagnostics limited
    - No consistency across ODMs
    - Functional issues, e.g. touch screen test for resistive (not capacitive) technology
- PLAN B: port our Linux diagnostics
  - Turned out to be very easy
- Getting to run low-level testing was interesting
  - (More on “root” next)
- Surprises testing high-level aspects
  - Framework in the way – e.g. can't disable statusbar without hacks
    - “service call activity 79 s16 com.android.systemui”



# Getting to "root"

- Need "root" to perform useful low level diagnostics
- The hard way – modify firmware image
  - Multiple approvals – Google, ODM, OEM, carrier
  - Update requires new round of permissions
  - Not realistic for multi-party, 3<sup>rd</sup> party solutions
- The easy way – just hack it
  - Root on any device, but needs frequent updates
    - "cmdclient misc\_command ;mount -o remount,rw /system"
    - "\*p = atomic\_read(&sensor\_data)"
    - CVE-2011-3874, CVE-2011-1823, CVE-2011-1149
- Google, are you listening?
  - ***We need "legal" root!***

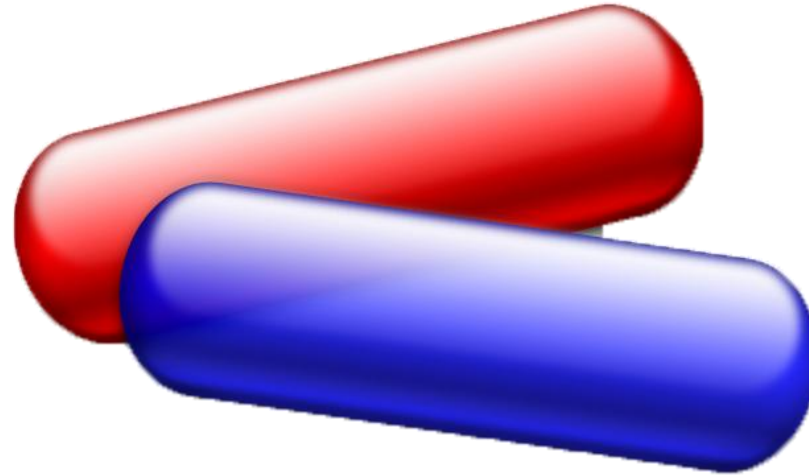


## unrevoked

Set your phone free.



# Part 3 – Telemetry collection and analysis



**Do you know how much  
money you ship each day?**

**NOT WITHOUT TELEMETRY**

*"The science and technology of automatic measurement and transmission of data ... for recording and analysis."*

– [thefreedictionary.com](http://thefreedictionary.com)

# Privacy and Telemetry



- *"A privacy-preserving data mining technique must ensure that any information disclosed 1. cannot be traced to an individual; or 2. does not constitute an intrusion."*
  - Vaidya, Clifton, Zhu (2005) *Privacy Preserving Data Mining*
- *"Personally identifiable information" (PII) is "any other information concerning an identified individual that, if disclosed, will result in contacting or identifying such individual physically or electronically."*
  - **Out-of-context**, but helpful, 11 U.S.C. 101(41A)(B)(ii)
- One solution: center on system, not the user
  - Keep PII separate from telemetry pipeline
- Provide opt-in/opt-out *but highlight the end-user value of opt-in*



# Telemetry Sources and Content

- Preloaded diagnostics
- Service diagnostics
- Manufacturing diagnostics




# Telemetry Analysis



- Problem: turn terabytes of gzipped XML into something useful
  1. Keep it **actionable**, i.e. recent, accurate and relevant
  2. Don't count on much guidance from others
  3. Don't use billion dollar consulting firm or expensive hardware
- Hardware plan A: Amazon Web Services, monthly runs
  -  cost of processing, frequency, AWS performance
- Hardware plan B: In-house servers
  - So far, so good
- Data flow plan A: XML to JSON, then CSV, reports from CSV
  -  not efficient enough, too much manual work, consistency easily lost
- Data flow plan B: XML into MonetDB, then data sets, then reports
  - Scripts create and refine targeted data sets
  - Targeted data prettied up for distribution and human consumption





# Telemetry Experiences

- Insufficient  data for general conclusions
- Success stories
  - Very high acceptance rates by end users
  - Component life-expectancy analysis
  - Applications with frequent crashes
  - Device drivers with high crash rates
  - Service providers not following established processes
  - Documentation






# Takeaways

- *"Writing diagnostics for  is like Linux"*
- Drive down costs by focusing on NTF and repeat returns
  - Give users diagnostic tools that are approachable
  - Follow processes
- Collect telemetry and analyze it
  - Consider not telling marketing (at first)
- Urge Google to enable 3<sup>rd</sup> party low-level diagnostic tools for 

# Q&A



- Backup Question 1: *"What can we as an industry do to make  devices easier to diagnose?"*
- Backup Question 2: *"How does  compare to iOS and Windows 8 for ARM in terms of hardware diagnostics?"*
- Backup Question 3: *"What difference is there between  on ARM vs. x86 from a diagnostic perspective?"*