Open Source JavaCard Development

FOUND ON JAVACARD.PRO

Smart(**Java**)Card

...

What & **Why**

What - smart card

- Tiny PC without Human Interface capabilities
  - **CPU**: 16b/32b RISC @ handful of MhZ
    - Math co-processor: RSA/DES/AES/ECC
  - **RAM**: X KB
  - **HDD**: XX..XXX KB (EEPROM)
  - **NET**: "Ethernet" (contact) or "WiFi" (contactless)
- *"The size of a Raspberry Pi but with specs worse than XT!"*

Application **P**rotocol **D**ata **U**nit

BIBO

Bytes go **I**n & **B**ytes come **O**ut

(request - response)

```
# Sent
00A4040000
# Received in 40ms
6F648408A000000151000000A5589F6501FF9F6E06479120813B00734906072A864886FC6B01600B06092A864886FC6E
0C060A2B060104012A026E01029000
# Sent
80500000088D767EAB341C1E1A
# Received in 50ms
000023340088249646620102000008BA2FFCEA96CCB3C8081E13DCBC49000
# Sent
84820100104D886E086980E2832D89B330F6DB6C84
# Received in 49ms
9000
# Sent
84F280000A4F003299F2EBF943CC04
# Received in 37ms
08A0000001510000000019E9000
# Sent
84F240000A4F0052829C70D6649C70
# Received in 33ms
6A88
# Sent
84F220000A4F00F64695C975B2B76D
# Received in 37ms
07A0000001515350010090000
# Sent
84F210000A4F00A7336CE7565FC8BB
# Received in 40ms
07A0000001515350010001080A0000001515350419000
# Sent
84CA00E008CDD0C7B6D7082EBF00
# Received in 35ms
E012C00401018010C00402018010C004030180109000
# Sent
84D801814B018010307661957681AC8BD382CF20D33A941F03FE6B6380108D83605E28E0B756CE6A5C1C0C2BC371033F
# Received in 166ms
01FE6B633FBF686274D79000
```

What - JavaCard

- **BASIC** in **BIOS**: Java VM

- **DOS**: App(let) manager (GlobalPlatform)

Choose your Weapon

- **ASM** / **C** (OpenCard* by CryptoExperts)
- **C** (MULTOS)
- **BASIC** (BasicCard by ZeitControl)
- **Java** (JavaCard)

Why - JavaCard

- **Meaningful abstraction layer**
- Commodity platform
  - **Multiple vendors**
- Multiple applications
- "Open platform" - Oracle ...
- "Portable" - Java ...

From **Academia** and **Business**

to

Open Source Developers

Step 1

Get the necessary hardware

Open JavaCard

- At least 3 online shops in EU (in English)
    - + Canada, US
- **Must be OPEN Java Card**
    - No "rooting" yet ;(
- Form factor: **ID-1** ("credit card") or **USB token**
- From **5€** (Feitian) to **50€** (NXP)
- javacard.pro / Google:

"JavaCard Buyer's Guide of 2015"

What to ask / look out for

- **JavaCard version**: 2.2.2, with 3.0.1 and 3.0.4 becoming popular. **Bigger is better** but for actual rollout check the necessary features, algorithms and maybe try to aim for 2.2.2-compatible code.
- **GlobalPlatform version**: 2.1.1 and 2.2 are common. This relates to loading your application to the card and 2.1.1 is sufficient, while 2.2 adds SCP03 support, which uses AES instead of 3DES.
- **EEPROM size**: 64K, 72K, 128K, 144K and bigger sizes are common. **Bigger is better**, but when actually rolling out your card, choose a size that is with optimal price/size depending on actual requirements.
- **GlobalPlatform default keys** (or **test keys**, with the value `404142434445464748494A4B4C4D4E4F` or `40..4F` for short): only if you get default test keys (or otherwise known keys) shall you be able to load applications to the card. You **shall not be able to load your application to the card without the keys**. Always be sure to ask for test keys for sample cards!
- **Contact/Contactless interface**: for creating NFC applications you want to get a card with **dual interface** or even contactless-only.
- **Proximity cards**: for opening doors, usually a different chip is present on the card for this single purpose. But a vendor can usually combine necessary physical access cards with a suitable JavaCard chip module.
- **Common Criteria / FIPS validation**: most *serious* smart cards have some form of certification. CC EAL5+ and FIPS 140 level 3 being common for the JavaCard part. **Bigger is better** but keep in mind, that " the use of a validated cryptographic module in a computer or telecommunications system does not guarantee the security of the overall system." (excerpt from FIPS 140-2)
- **GlobalPlatform lifecycle**: should OP_READY, but keep in mind that certain pre-personalization steps (like changin physical characteristics of the chip) can only be done before this state and are usually proprietary. Keep this in mind when actually rolling out.

Manufacturers

Supported cards (with a confirmed shop link)

- SmartCafe Expert 3.2 72K JavaCard 2.2.1/GlobalPlatform 2.1.1 12€
  - Virgin cars require unlocking with "-emv"
  - and other products with same name but different EEPROM + connectivity:
  - http://www.smartcardfocus.com/shop/ilp/id~684/smartcafe-expert-6-0-80k-dual-/p/index.shtml
  - http://www.smartcardfocus.com/shop/ilp/id~521/smartcafe-expert-3-2-72k/p/index.shtml
  - http://www.smartcardfocus.com/shop/ilp/id~523/smartcafe-expert-3-2-144k-dual/p/index.shtml
- JCOP J3D081 v2.4.2 JavaCard 3.0.1/GlobalPlatform 2.2 40€
  - and other products with same
  - http://www.cryptoshop.com/products/smartcards/jcop-31-v2-4-1-72k.html
  - http://www.cryptoshop.com/products/smartcards/j2a081-v2-4-1-jcop-21.html
  - http://www.smartcardfocus.com/shop/ilp/id~685/j3a041-40k/p/index.shtml
  - http://www.smartcardfocus.com/shop/ilp/id~688/j3d081-80k/p/index.shtml
  - JCOP v2.4.1 NXP J3A080 Dual Interface Card (10 pcs.) 110€
- Gemalto
  - GEMALTO IDCORE 10 - GEMALTO TOP IM GX4 JavaCard 2.2.1/GlobalPlatform 2.0.1 16€
  - Virgin cars require unlocking with "-visa2 -key "
  - Instead of a reasonable error code a failed transaction is returned on errors.
  - GEMALTO IDCORE 3010 CC / TOP DM CC 25€
- Feitian JavaCard-s
  - http://www.smartcardfocus.com/shop/ilp/id~711/javacos-a40-dual-interface-java-card-64k/p/index.shtml
  - http://www.smartcardfocus.com/shop/ilp/id~712/javacos-a22-dual-interface-java-card-150k/p/index.shtml

Smart Card Reader

- Any* will work (Contact)
    - Ludovic Rousseau's **USB CCID** driver (298/323)
        - Google: "Readers sorted by 'section' field"
- Carefully consider contactless
- **PC/SC is not a hardware standard!**

Step 2

Prepare your tools

1. Normal **Java development**
    - Favourite editor, IDE, compiler
    - **Catch**: running requires emulation
2. **Conversion** into card-loadable format (CAP file)
    - Against Oracle's JavaCard SDK
3. **Loading** onto card
    - Using GlobalPlatform

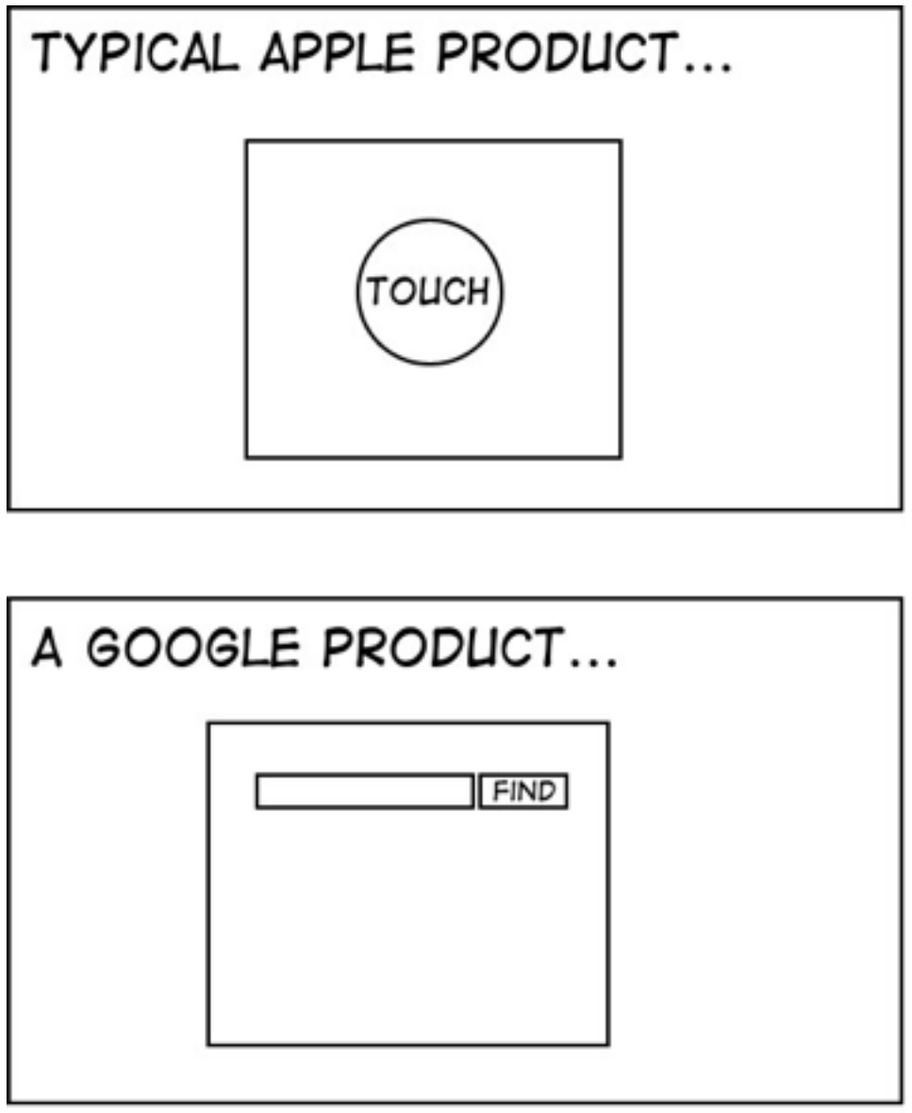
JavaCard SDK

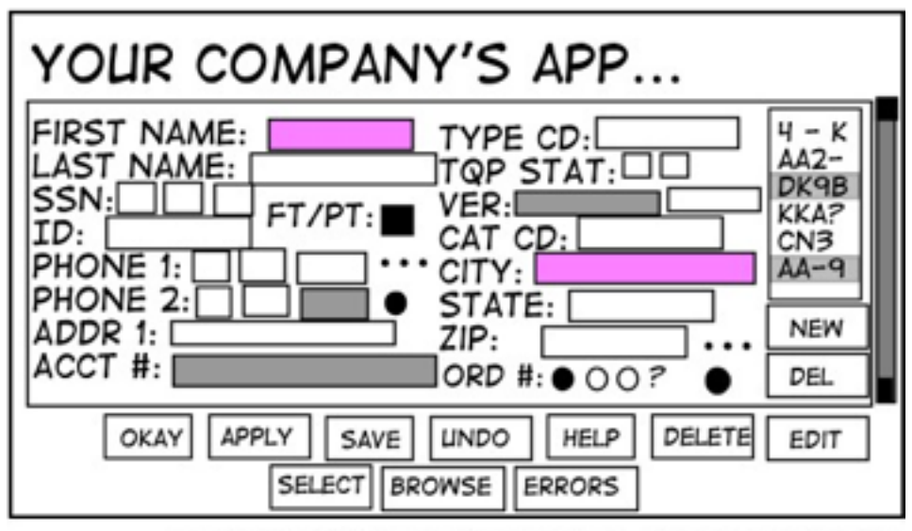
- From Oracle ...
  - No OpenJavaCardSDK :(
- Java components are cross-platform
- Suitable max version **depends on card version**.

ant-javacard

- ANT task for turning Java source code into a loadable CAP file
  - **Any platform** (Linux, OS X, Windows)
  - **Any version** of JavaCard SDK
- Simple. Easy to use. **Seriously.**

```
<property name="src" location="applet/src"/>
  <property name="build" location="applet/bin"/>
  <property name="test.build" location="test/bin"/>
  <property name="test.lib" location="test/lib"/>
  <!-- Load user specified extra properties -->
  <property file="${user.home}/javacard.properties"/>
  <property name="JAVA_PACKAGE" value="openpgpcard"/>
  <property name="JAVA_PACKAGE_DIR" value="openpgpcard/"/>
  <property name="APPLET_NAME" value="OpenPGPApplet"/>
  <property name="PACKAGE_AID" value="0xd2:0x76:0x00:0x01:0x24:0x01"/>
  <property name="APPLET_AID" value="0xd2:0x76:0x00:0x01:0x24:0x01:0x02:0x00:0x00:0x00
  <property name="VERSION" value="0.1"/>
  <target name="init">
    <mkdir dir="${build}"/>
    <mkdir dir="${test.build}/output"/>
  </target>
  <target name="compile" depends="init" description="compile the source" unless="test.
    <javac srcdir="${src}" destdir="${build}" includeantruntime="false" source="1.5" t
      <classpath>
        <pathelement path="${JAVACARD_HOME}/lib/api.jar"/>
      </classpath>
    </javac>
  </target>
  <target depends="compile" name="convert" description="convert to .cap" unless="test.
    <java classname="com.sun.javacard.converter.Converter" fork="true" failonerror="tr
      <arg line="-classdir ${build}"/>
      <arg line="-verbose"/>
      <arg line="-exportpath ${JAVACARD_HOME}/api_export_files"/>
      <arg line="-out CAP JCA EXP"/>
      <arg line="-applet ${APPLET_AID} ${APPLET_NAME}"/>
      <arg line="${JAVA_PACKAGE} ${PACKAGE_AID} ${VERSION}"/>
      <classpath>
        <pathelement location="${JAVACARD_HOME}/lib/converter.jar"/>
        <pathelement location="${JAVACARD_HOME}/lib/offcardverifier.jar"/>
      </classpath>
    </java>
  </target>
```





STUFFTHATHAPPENS.COM BY ERIC BURKE

Similar projects

- standard JavaCard SDK Ant tasks
  - :(as cumbersome to use as the command line utilities
  - :(not declarative/DWIM enough
  - :) very explicit interface with all details exposed
- gradle-javacard (Apache 2.0) - https://github.com/fidesmo/gradle-javacard
  - :) nice declarative interface
  - :(requires gradle (40M download)
  - :(JavaCard 2.2.2 only
- EclipseJCDE (Eclipse 1.0) - http://eclipse-jcde.sourceforge.net/
  - :(JavaCard 2.2.2 only
  - :(not possible to integrate in CI - depends on eclipse
  - :(essentially an Eclipse GUI wrapper for JC SDK
- JCOP Tools
  - :(not open source
- NetBeans IDE JC support
  - :(not possible to integrate into CI
  - :(JavaCard 3.0 only
  - :(Netbeans, not cross platform
- Maven2 task from FedICT (LGPL3) - https://code.google.com/p/eid-quick-key-toolset
  - :(Maven downloads half the internet before even simple tasks
  - :(JavaCard 2.2.2 only
- Ant script files with templates
  - :(XML is a *very* bad and verbose programming environment

```
<taskdef name="javacard" classname="pro.javacard.ant.JavaCard" classpath="lib/ant-javac
<javacard>
  <cap jckit="${JAVACARD_HOME}" output="MyApplet.cap" sources="src/openpgpcard">
    <applet class="openpgpcard.OpenPGPApplet" aid="D2760001240102000000000000010000"/>
  </cap>
</javacard>
```

Application **ID**entifier

GlobalPlatform

- Every package (CAP file) has an AID
  - Each applet (class) has an AID
- Every on-card entity has an AID
  - Packages and classes and instances
- **5..16** bytes (5+11)

GlobalPlatformPro

- Easy to use Java tool to:
  - LOAD CAP files to the card
  - INSTALL applets (AID-s)
  - CREATE applet instances (AID-s)
  - DELETE applets and packages (AID-s)
  - Add/change/delete keys
  - And more ...

Lock/Unlock

$ gp -l
AID: A000000003000000 (|........|)
    ISD SECURED: Security Domain, Card lock, Card terminate, Default selected, CVM (PIN) management

AID: A0000000035350 (|.....SP|)
    ExM LOADED: (none)
    A00000003535041 (|.....SPA|)

$ gp -lock B4F75CE0A95EA3F86BBD051CB77C0FAE
Card locked with: DES3:B4F75CE0A95EA3F86BBD051CB77C0FAE
Write this down, DO NOT FORGET/LOSE IT!
$ gp -l
openkms.gp.GPException: STRICT WARNING: Card cryptogram invalid!
Card: CC73F92AD03A131D
Host: A358609D53744EEB
!!! DO NOT RE-TRY THE SAME COMMAND/KEYS OR YOU MAY BRICK YOUR CARD !!!
        at openkms.gp.GlobalPlatform.printStrictWarning(GlobalPlatform.java:156)
        at openkms.gp.GlobalPlatform.openSecureChannel(GlobalPlatform.java:476)
        at openkms.gp.GPTool.main(GPTool.java:348)
$ gp -key B4F75CE0A95EA3F86BBD051CB77C0FAE -unlock
Default DES3:404142434445464748494A4B4C4D4E4F set as master key.
$ gp -l
AID: A000000003000000 (|........|)
    ISD SECURED: Security Domain, Card lock, Card terminate, Default selected, CVM (PIN) management

AID: A0000000035350 (|.....SP|)
    ExM LOADED: (none)
    A00000003535041 (|.....SPA|)

Step 4

Learn, Learn, Learn

Read

- **JavaCard API Specification**
  - and Runtime Environment
  - Google: *"JavaCard Tutorial"*
- **ISO 7816-4** (and **javacard.framework.APDU**)
  - Google: *"University Smart Card Paper"*
  - CLA/INS/P1/P2/Lc/Le/SW/0x9000
- ISO 7816/14443, ETSI, BSI, NFC, NIST etc etc
- Beware of outdated/wrong/irrelevant information on the web!

ISO 7816-7 (1999)

Structured Card Query Language

AppletPlayground

- "Ready to eat" dog food from the internet
    - Almost all open source applets that *may* do *something*
- Import into Eclipse
- Build with ANT (eclipse/cmdline)

Included applets

- MuscleApplet - as was found in martinpaljak/MuscleApplet@d005f36209bdd7020bac0d783b228243126fd2f8 (BSD)
- CoolKeyApplet - r105 from http://svn.fedorahosted.org/svn/coolkey/trunk/applet (BSD/LGPL2.1)
- PKIApplet - r65 from http://svn.code.sf.net/p/javacardsign/code/pkiapplet/src (LGPL2.1)
- OpenPGPApplet - Yubico/ykneo-openpgp@ed928351994b053f3d87ec00ec4a9696d4ff20fe (GPL2)
- FluffyPGPApplet* - FluffyKaon/OpenPGP-Card@545da17f82ff4627758674bbcbb0e602e959d9dd (GPL3)
- YkneoOath - Yubico/ykneo-oath (GPL3)
- PassportApplet - http://sourceforge.net/p/jmrtd/code/HEAD/tree/trunk/passportapplet/ (LGPL3)
- BTChip* - LedgerHQ/btchipJC (AGPL3)
- NDEF - slomo/ndef-javacard (DO WHAT THE FUCK YOU WANT TO PUBLIC LICENSE :))
- BeID* - r62 (LGPL)
- OpenEMV - r3 from svn://svn.code.sf.net/p/openemv/code/trunk (LGPL2)
- ISOApplet - philipWendland/IsoApplet (GPL3)
- DriversLicense* r175 from svn://svn.code.sf.net/p/isodl/code/ (LGPL2)
- PLAID - (public license?, no source linke)

Note: applets marked with * have obvious blocking errors (missing casts from int to short for 2.2.X target) removed from source.

Step 5

Engage with the Community

- Oracle JavaCard Forum / kenai.com: **dead**
- Stack Overflow: "javacard", "globalplatform", "smartcard" tags: **some life**
- OpenSC / pcsc-lite lists: **open source but no Java**
- GitHub: **depends**
- IRC: **#opensc**

javacard.pro