TIZEN™ DEVELOPER CONFERENCE
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Understanding the Permission and Access Control Model for Tizen Application Sandboxing

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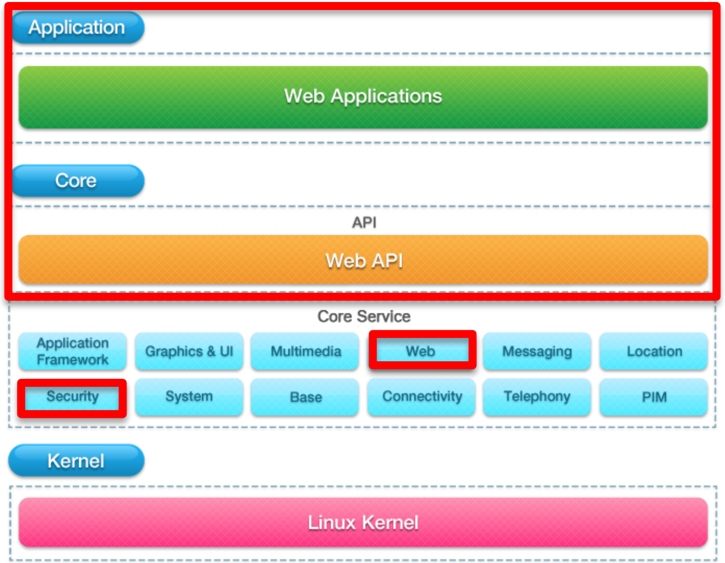
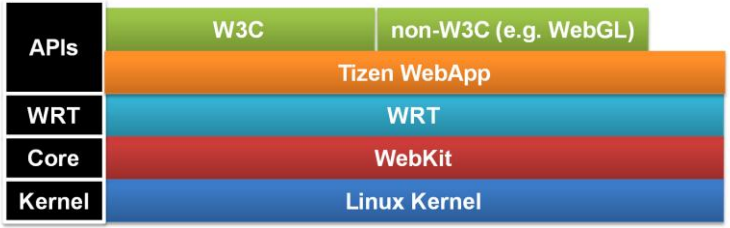
Motivation

- The **Tizen application model** is based on Web technologies:
  - **HTML5 + JS + CSS + Web APIs**
- **Tizen WRT** supports **Tizen widgets** and multiple APIs: **W3C, non-W3C** (e.g. WebGL) and **Tizen Web API**
- **Web-Runtime** is the application that handles widget **installation** and **execution**
- **Security** of **WRT** and **widgets** is crucial for the ecosystem
- **Our talk**:
  - Overview of Tizen Security Framework and SMACK (Simplified Mandatory Access Control Kernel)
  - Widget access control and permissions
  - WebRunTime access control enforcement
  - Widget Sandbox

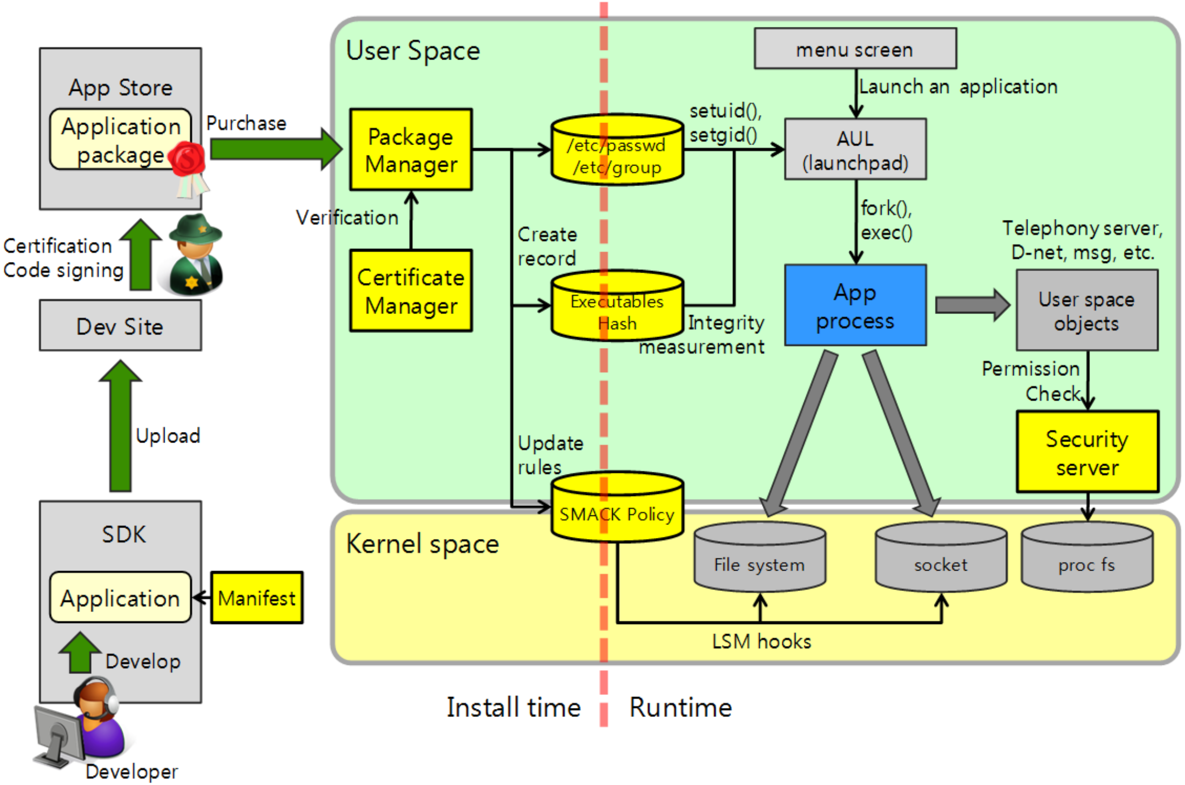
Tizen Architecture





Overview of Tizen Security Framework

- **SMACK** as the main system-level **access control mechanism**
- **Web Runtime** enforces fine-grained **controls** over **Tizen WebApps**
- **SMACK-based** process **sandbox** over widget processes

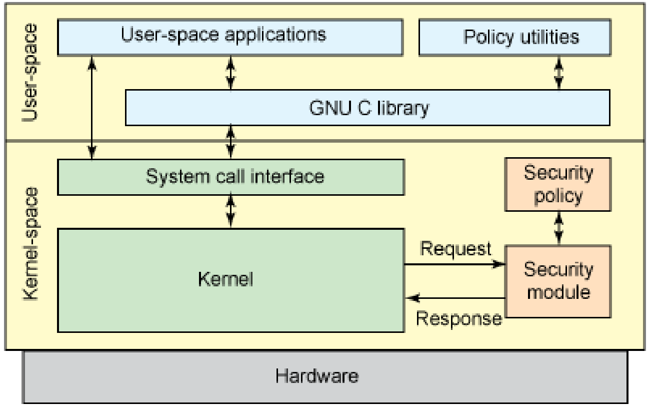


Contents

- Overview of the Tizen Security Framework
  - SMACK Overview
- Widget Permissions and Access Control Model
  - Feature Declarations in Manifest
  - User Prompt Types
  - Widget Access Request Policy (WARP)
  - Sample Manifest and Policy Files
- Setting Security Configurations in Tizen SDK
- Access Control Enforcements on Tizen WebApps
  - WRT Access Control Engine
  - SMACK Sandbox
- Conclusions

SMACK Overview

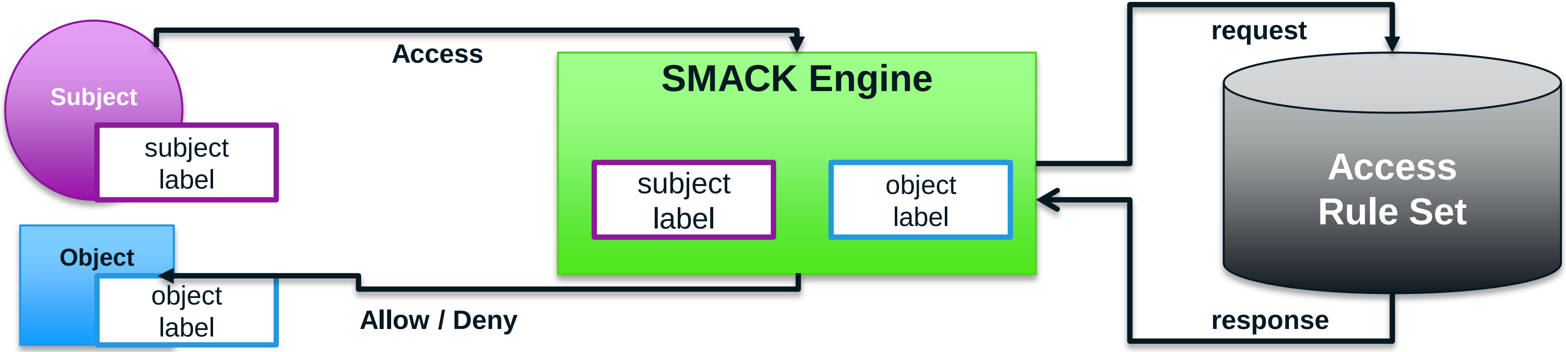
- **S**implified **M**andatory **A**ccess **C**ontrol **K**ernel
  - Linux Security Module included in the Linux Kernel
- **SMACK Terms:**
  - **Subject**
    - an active entity that performs the access
  - **Object**
    - a passive entity that is accessed
  - **Access**
    - an access attempt from Subject to Object
  - **Label**
    - a “security tag” applied to subjects (i.e., processes) and objects (i.e., file-system objects, sockets, processes). Used to identify the entity SMACK



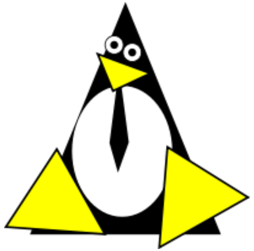
SMACK Overview

- **SMACK Labels:**
  - Two label types: process labels and object labels
  - Extended file attributes to store SMACK label configuration
    - **SMACK64:** XATTR for file-system objects
    - **SMACK64EXEC:** XATTR for executables. Becomes process label upon exec()

- **SMACK Accesses:**



SMACK Overview



- **SMACK Rules:**
  - **Rule format:**
    - **[subjectLabel] [objectLabel] [access(rwxa)]**
  - /usr/bin/cat → **SMACK64EXEC** = catApp
  - /home/user/documents/file1.txt → **SMACK64** = myFile
  - Example Rule to allow cat to read file1.txt

    catApp myFile r
  - Rule to allow cat to read & write file1.txt

    catApp myFile rw

Widget Permissions and Access Control Model

- A **subset** of the **JavaScript APIs** supported in Tizen are considered **restricted**
  - **Restricted** refers to any JS function that can **access** the **private data** on a **device** such as location, contacts, calendar, etc.
- **Widgets** need **authorization** to invoke **restricted APIs**
- Permission declarations and authorization:
  - Declaration in **manifest file**:

    <feature> element for device APIs

    <access> element for network resources
  - Authorization:

    prompt type decision according to WRT ACE **policy**

    user confirmations

Widget Permissions and Access Control Model

- **Developers** must **declare** in the ***manifest file*** *of a widget,* which ***features*** the widget wants access to.

Feature Declaration “template” from W3C

```
<widget xmlns="http://www.w3.org/ns/widgets">
        <feature name = "http://example.com/api/contact" required = "false"/>
</widget>
```

Feature Declaration “implementation” for Tizen

```
<widget xmlns="http://www.w3.org/ns/widgets" xmlns:tizen="http://tizen.org/ns/widgets" version="1.0" >
        <feature name="http://tizen.org/api/contact” required="false"/>
</widget>
```

Widget Permissions and Access Control Model

API Group	Feature / Device Capability	API Functions
Time	**http://tizen.org/api/time** **http://tizen.org/api/time.read** **http://tizen.org/api/time.write**	**All** **All except setCurrentDateTime()** **setCurrentDateTime()**

JavaScript:

```
…
var current_dt = tizen.time.getCurrentDateTime();
var is_leap = tizen.time.isLeapYear(current_dt.getFullYear());
 if (is_leap)
   console.log("This year is a leap year.");
…
```

Manifest File:

```
…
<feature name="http://tizen.org/api/tizen"/>
<feature name="http://tizen.org/api/time.read"/>
…
```

**See Appendix for the full Tizen Web API list*

Widget Permissions and Access Control Model

- **W3C Widget Access Request Policy (WARP)**
  - All network accesses by widgets are denied by default
  - A widget must declare in its manifest which network resources it will access (such as XMLHttpRequest, iframe, img, script, etc.)
  - <access> element in config.xml. Developers can specify protocols, domains, and sub-domains.

```
<widget xmlns="http://www.w3.org/ns/widgets">
...
...
        <access origin="https://example.net"/>
        <access origin="http://example.com"/>
...
</widget>
```

```
<access origin="http://example.org"
subdomains="true"/>
```

```
<access origin="http://example.org:8080"
subdomains="false"/>
```

```
<access origin="*" />
```

Widget Permissions and Access Control Model

Sample Manifest file:

```
<?xml version="1.0" encoding="UTF-8"?>

<widget xmlns="http://www.w3.org/ns/widgets" xmlns:tizen="http://tizen.org/ns/widgets" version="1.0"
id="http://YourDomain.com/SampleContact" viewmodes="fullscreen">
            <icon src="icon.png"/>
            <name>SampleContact</name>
            <content src="index.html"/>
            <description>Sample application for Tizen contact module.</description>
            <license/>
            <feature name="http://tizen.org/api/tizen" required="true"/>
            <feature name="http://tizen.org/api/contact" required="true"/>
            <feature name="http://tizen.org/api/contact.read" required="true"/>
            <feature name="http://tizen.org/api/contact.write" required="true"/>
            <access origin="http://jquerymobile.com" subdomains="true"/>
</widget>
```

Widget Permissions and Access Control Model

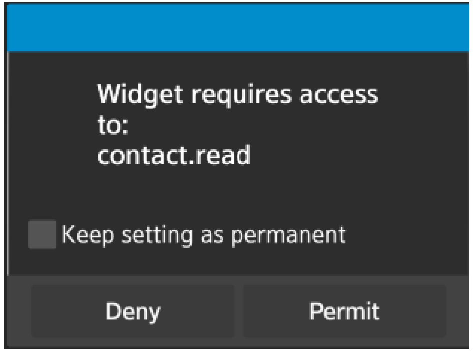
- A **feature** will be **granted** by the **WRT** based on the **policy** and the **confirmation** of the user to various **prompt** types
  - **Various** types of **prompts** are available (table)
  - **WRT ACE Policy** specifies which prompt type will be used in a specific situation

Prompt Types	
Blanket Prompt	User is prompted for confirmation the first time the API function is called by the widget, but once confirmed, prompting is never again required.
Session Prompt	User is prompted once per session.
One-Shot Prompt	User must be prompted each time the restricted API is invoked.
Permit	Use of the device capability is always permitted, without asking the user.
Deny	Use of the device capability is always denied

Widget Permissions and Access Control Model

- The **type** of **prompt** for each **API** is **determined** by the **policy**
- **Policies** are **driven** by **Operators** and **Device Manufacturers**
- Users can affect a policy through preference configuration, but only in a more restricted way

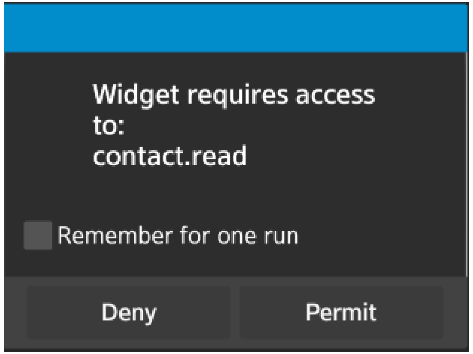
Blanket Prompt



Widget requires access to:
contact.read

□ Keep setting as permanent

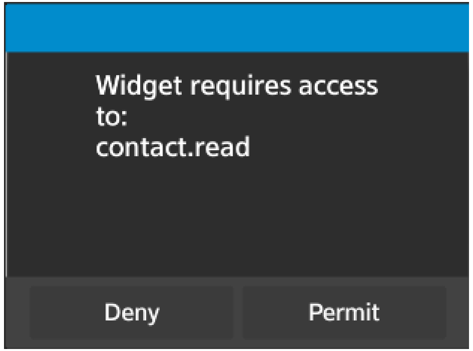
Session Prompt



Widget requires access to:
contact.read

□ Remember for one run

One-Shot Prompt



Widget requires access to:
contact.read

Widget Permissions and Access Control Model

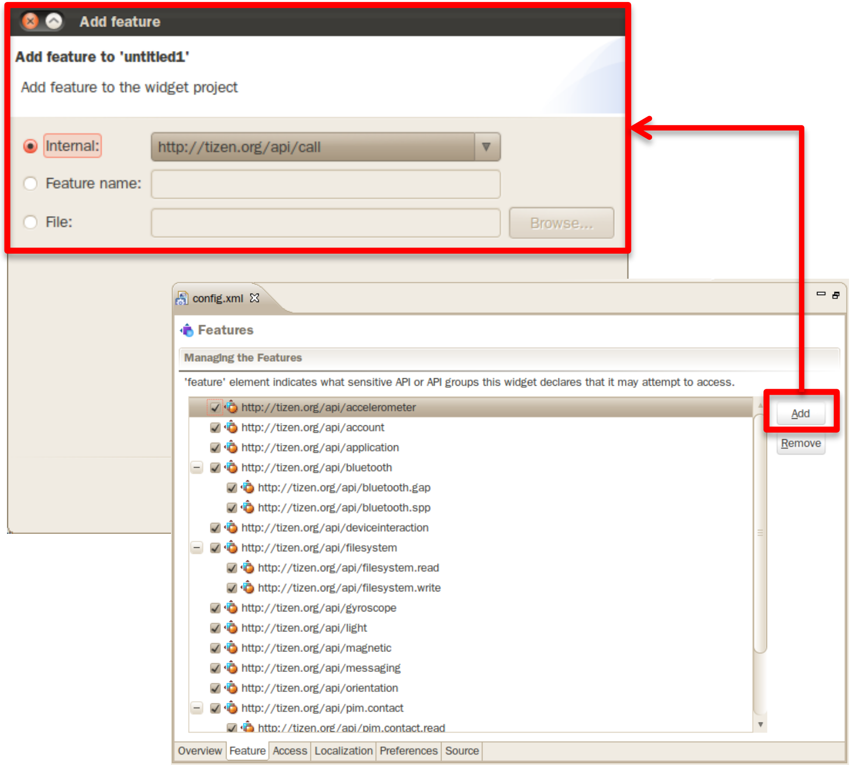
Sample Tizen Policy File

```
<policy-set id="Tizen-Policy" combine="first-matching-target”>
  <policy id="Tizen-Policy-Trusted" description="Tizen's policy for trusted domain" combine="permit-overrides”>
    <rule effect=”prompt-session"> <!– rules for specific resources -->
      <condition combine="and">
        <condition combine="or">
          <resource-match attr="device-cap" func="equal" match="XMLHttpRequest" />
          <resource-match attr="device-cap" func="equal” match="externalNetworkAccess" />
          <resource-match attr="device-cap" func="equal" match="messaging.send" />
        </condition>
        <environment-match attr="roaming" match="true" />
      </condition>
    </rule>
    <rule effect=”permit" /> <!– all other matches -->
  </policy>
</policy-set>
```

Setting Security Configurations in Tizen SDK

- **Tizen SDK** supports **feature** selection
  - **Developers** need to **manually choose** which **features** their applications require
- A **check box** on the **left** of a feature name indicates the **"required" attribute**. If this is **checked**, **config.xml** is as follows.

  <feature name="http://tizen.org/api/accelerometer" required="true"/>
- **Add Feature Dialog Box** allows a feature to be added in one of 3 ways:
  - **Internal**: It is possible to select a feature from a fixed list.
  - **Feature name**: A URL with a feature definition should be entered.
  - **File**: A name of a file with a feature definition (*.xml, *.widlprocxml) should be entered.



Add feature

Add feature to 'untitled1'

Add feature to the widget project

● Internal: http://tizen.org/api/call ▼

○ Feature name:

○ File: Browse...

config.xml ☒

Features

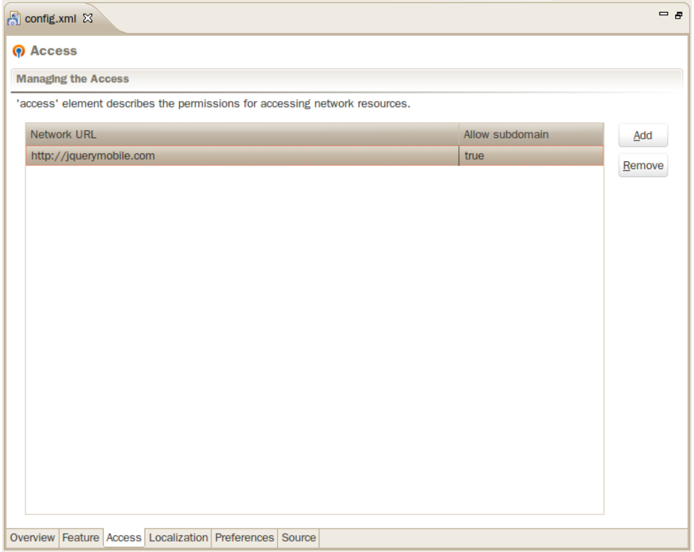
Managing the Features

'feature' element indicates what sensitive API or API groups this widget declares that it may attempt to access.

- ☑ http://tizen.org/api/accelerometer
- ☑ http://tizen.org/api/account
- ☑ http://tizen.org/api/application
- ☑ http://tizen.org/api/bluetooth
  - ☑ http://tizen.org/api/bluetooth.gap
  - ☑ http://tizen.org/api/bluetooth.spp
- ☑ http://tizen.org/api/deviceinteraction
- ☑ http://tizen.org/api/filesystem
  - ☑ http://tizen.org/api/filesystem.read
  - ☑ http://tizen.org/api/filesystem.write
- ☑ http://tizen.org/api/gyroscope
- ☑ http://tizen.org/api/light
- ☑ http://tizen.org/api/magnetic
- ☑ http://tizen.org/api/messaging
- ☑ http://tizen.org/api/orientation
- ☑ http://tizen.org/api/pim.contact
  - ☑ http://tizen.org/api/pim.contact.read

Setting Security Configurations in Tizen SDK

- Applications **CANNOT** access **external network resources** by **default** (WARP - W3C Access Requests Policy).
- Developers **must request permissions** for their **widget** to retrieve network resources.
- You can **enter multiple URLs** using the **Add button**.
- For each **URL**, you can **indicate** if you want to allow a widget to access the **sub-domains** for a URL. The "Allow subdomain" column contents can be toggled with a mouse click.



Managing the Access

'access' element describes the permissions for accessing network resources.

Network URL	Allow subdomain
http://jquerymobile.com	true

Manifest file:

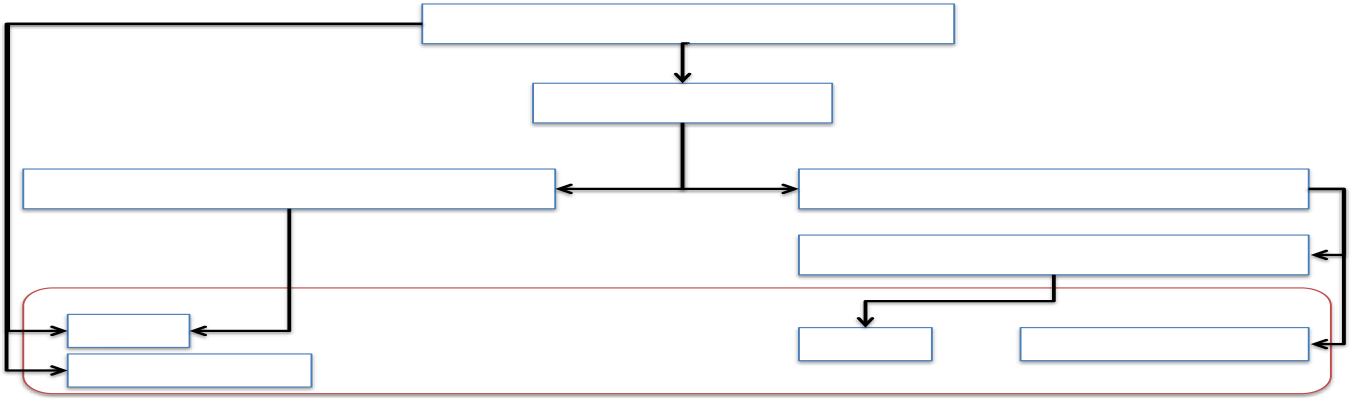
```
<access origin="http://jquerymobile.com”
subdomains="true"/>
```

Access Control Enforcements on Tizen WebApps

- **Tizen WRT** supports **Tizen WebApps** and multiple APIs: **W3C APIs**, and **non-W3C APIs** like WebGL and **Tizen Web API**
- **WRT** has a **multi-process** model
  - **WebKit** based
  - Widget **instances** are executed in **separate processes**
  - Provides **runtime isolation** and allows the system to **enforce custom process-level containment** (sandbox) on each **instance**
- Two levels of access control enforcements
  - **WRT Access Control Engine(ACE):** Fine grained access control on JS APIs
  - **Application Sandbox via SMACK:** Process-level containment by the kernel on system calls

Access Control Enforcements on Tizen WebApps

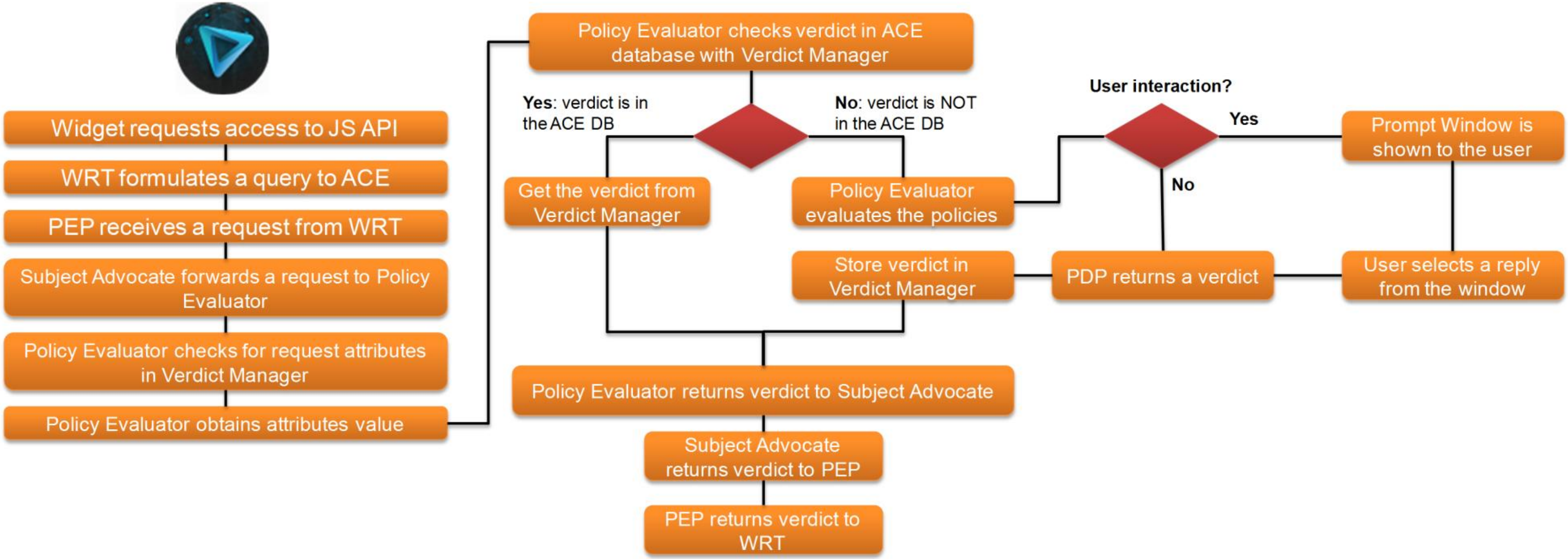
- **Access Control Engine (ACE) –** General Design



PEP: ACE interface for WRT
PIP: Responsible for obtaining attribute values from WRT, Resource Information and OS
PDP: Policy Decision Point, evaluates policies; Interacts with the user if necessary
Policy Translator: Parses policies (XML)
Verdict Manager: Responsible for caching the verdicts

Access Control Enforcements on Tizen WebApps

- **ACE Policy Evaluation** – General Flow:

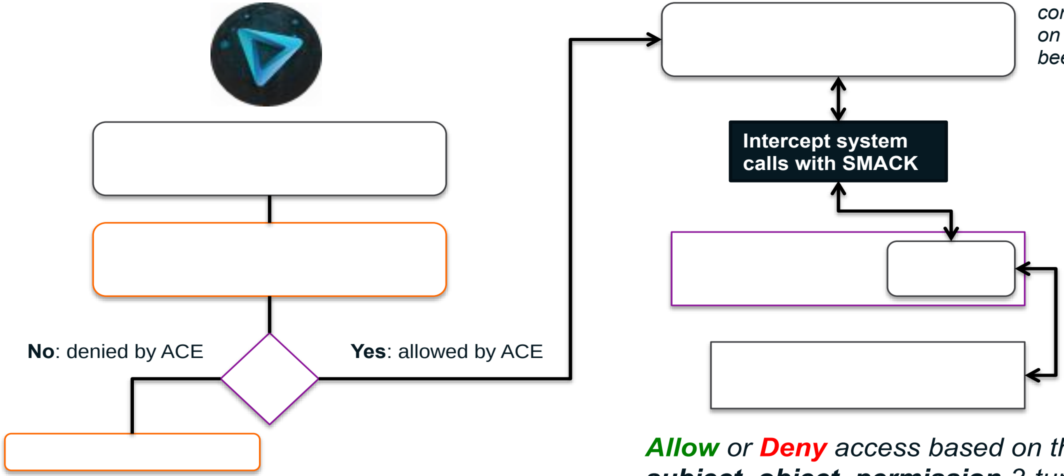


Widget requests access to JS API
WRT formulates a query to ACE
PEP receives a request from WRT
Subject Advocate forwards a request to Policy Evaluator
Policy Evaluator checks for request attributes in Verdict Manager
Policy Evaluator obtains attributes value
Policy Evaluator checks verdict in ACE database with Verdict Manager
Yes: verdict is in the ACE DB
No: verdict is NOT in the ACE DB
Get the verdict from Verdict Manager
Policy Evaluator evaluates the policies
User interaction?
Yes
No
Prompt Window is shown to the user
User selects a reply from the window
PDP returns a verdict
Store verdict in Verdict Manager
Policy Evaluator returns verdict to Subject Advocate
Subject Advocate returns verdict to PEP
PEP returns verdict to WRT

Access Control Enforcements on Tizen WebApps

- ## Widget Process Sandbox via SMACK

  The **SMACK Policy File** is updated with the appropriate **rules** for a **widget** during the **install**, **update,** or **uninstall** operations, as well as **at run-time**. The rules are based on the device features a widget requests in the **manifest file** packaged with a widget, **user confirmations**, and **security files** on the system that describe what **labels** and **permissions** are needed for each **device feature**.

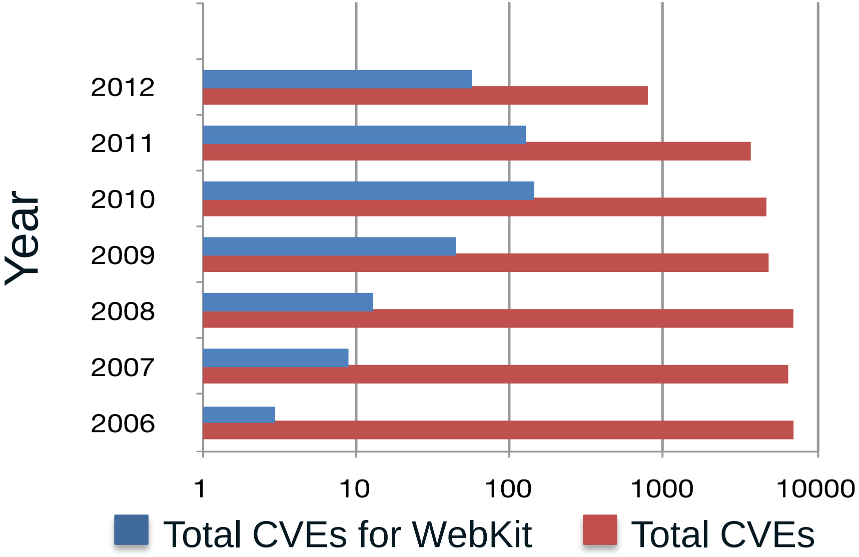


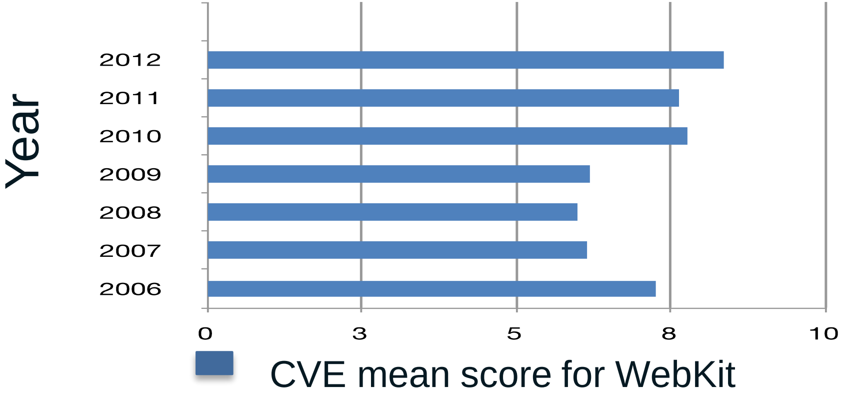
*corresponding files on the system have been **labeled***

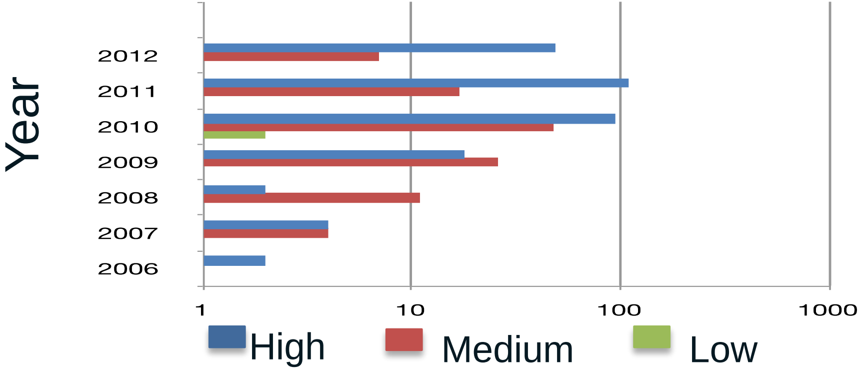
***Allow** or **Deny** access based on the **subject**, **object**, **permission** 3-tuple*

Access Control Enforcements on Tizen WebApps

- **Why do we sandbox widget processes?**
  - WebKit **vulnerability analysis** results
    - **CVE**: Common Vulnerabilities and Exposures







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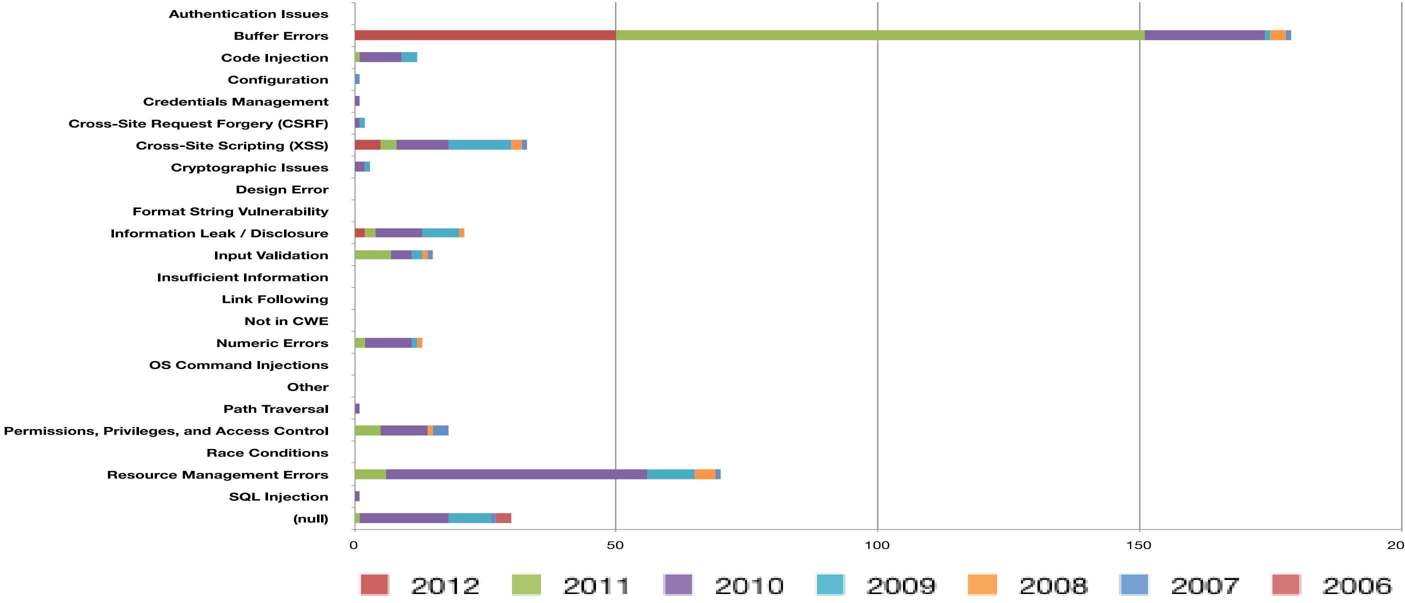
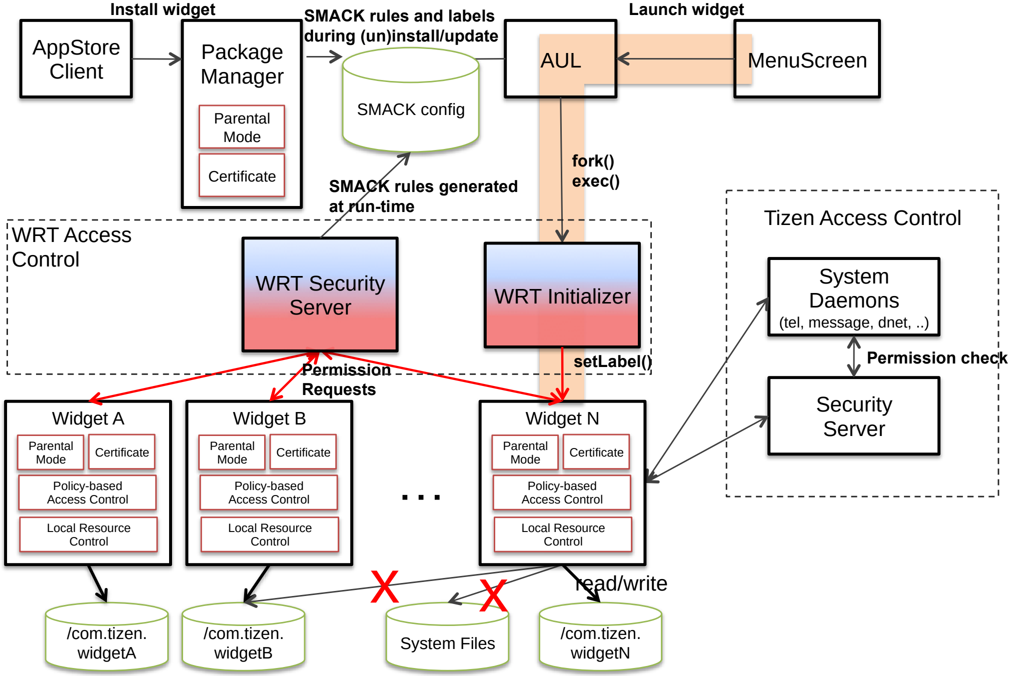


Access Control Enforcements on Tizen WebApps

- **Widget Sandbox via SMACK**:
  - Each **widget** runs in a **different security domain** (they have unique SMACK labels)
  - A **widget** process **cannot access the files of another widget**, system files (such as a contacts database), or communicate with other processes (such as a telephony daemon) unless the required SMACK rules are in place.
  - **SMACK rules** for a widget are configured:
    - during **install**, **uninstall**, and **update** operations by Package Manager
    - at **runtime** by the WRT Security Server.
    - as a result of **user prompts** according to which features are granted to that widget

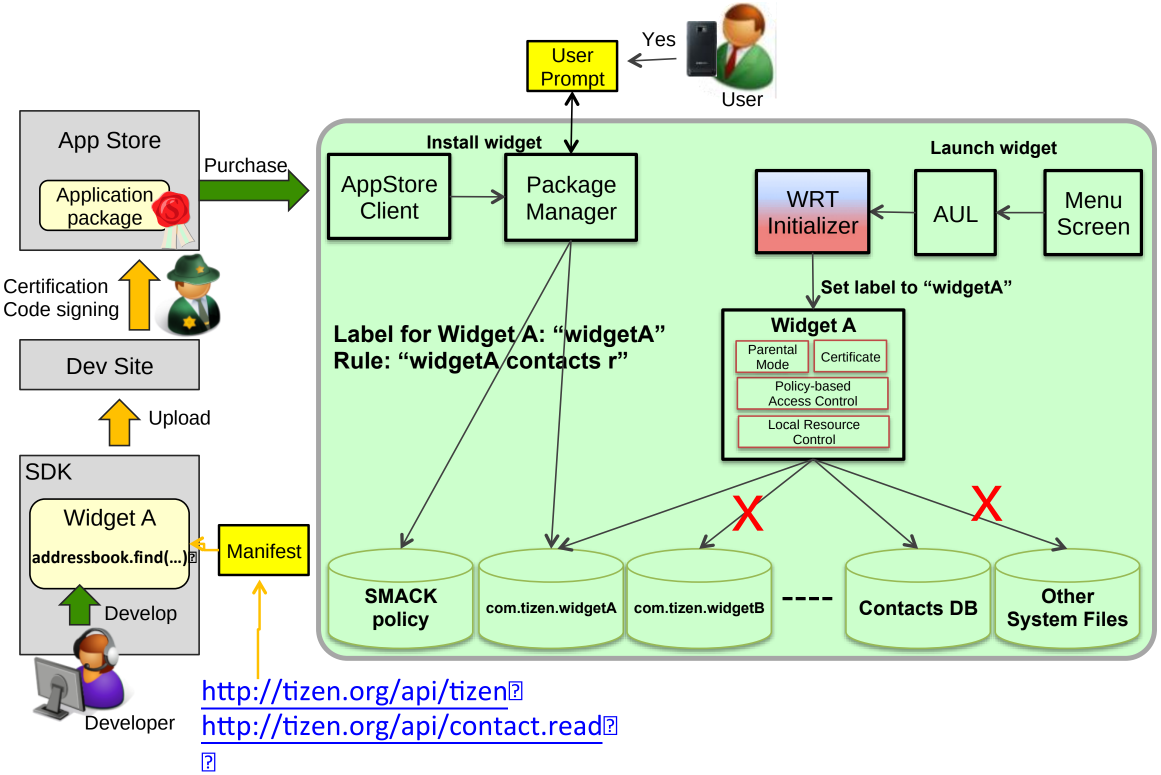


Access Control Enforcements on Tizen WebApps

- **SMACK Sandbox Example Flow:**
  - "Widget A" contains the following code snippet:

```
…
addressbook =
tizen.contact.getDefaultAddressBook();
addressbook.find(…);
…
```

  - **Read** access to the **Contacts DB** file
  - Assume device policy requires **blanket prompt** (*depends on the actual policy on the device)



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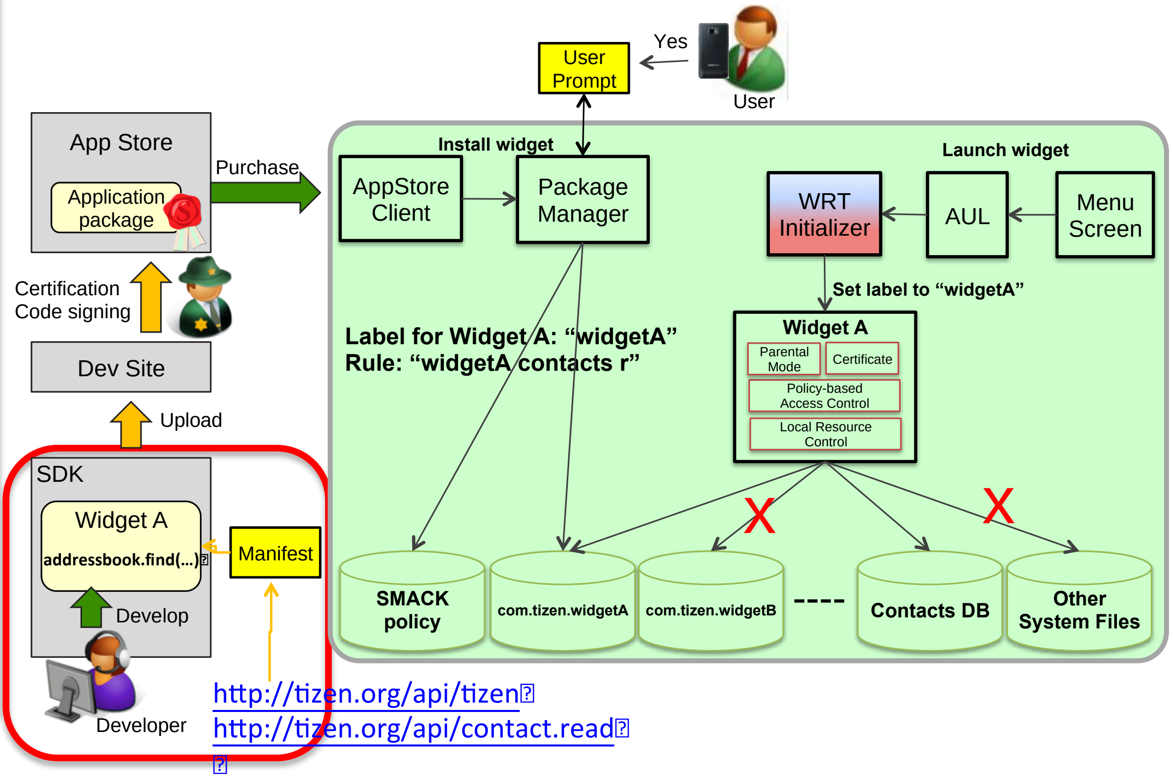

http://tizen.org/api/tizen
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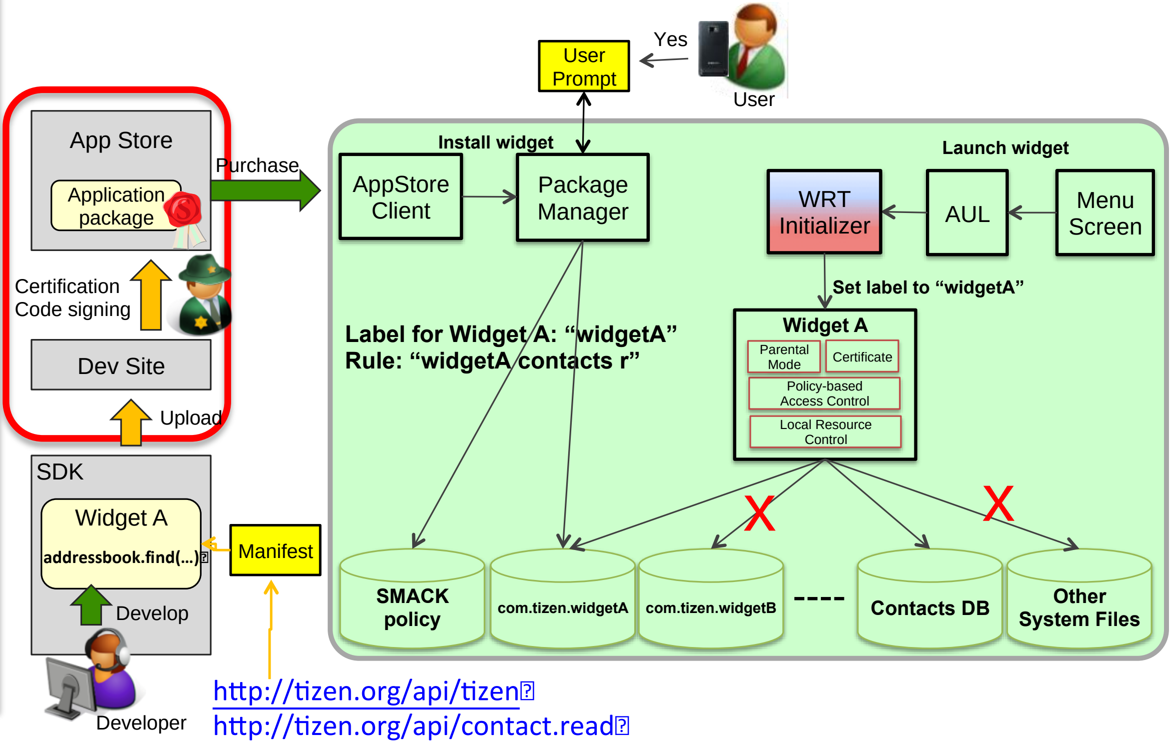

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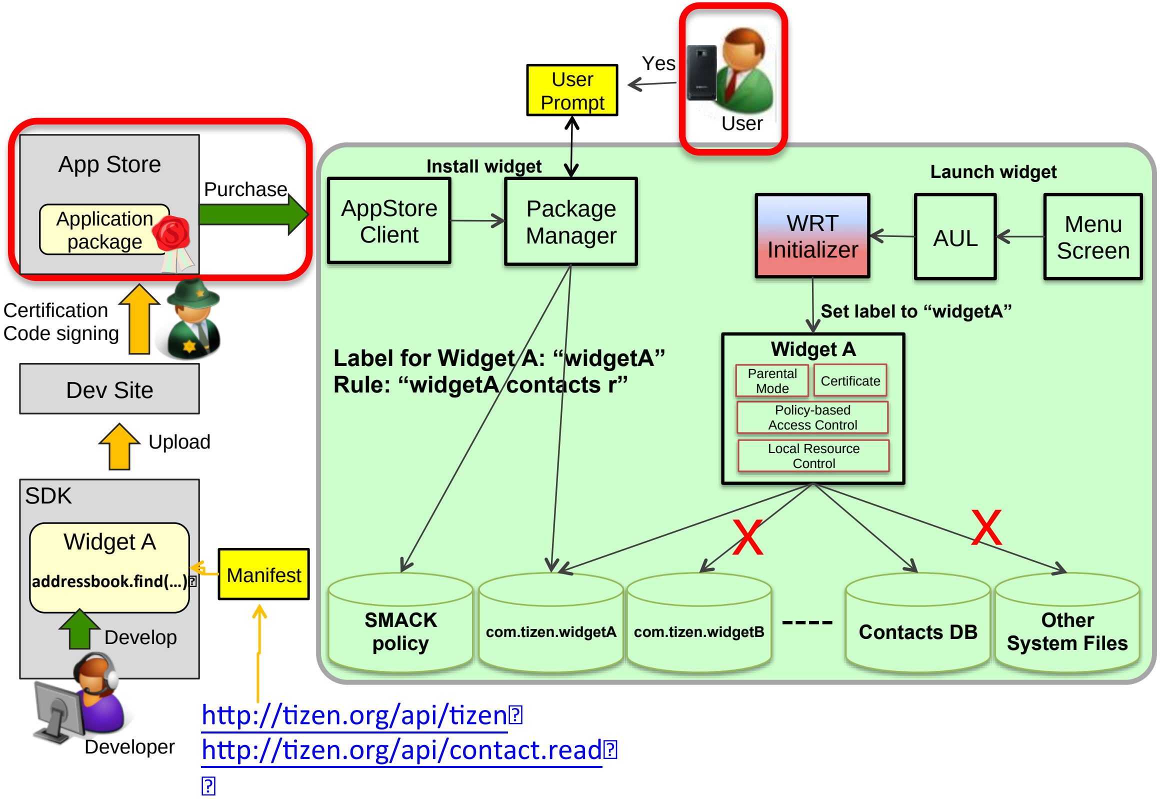

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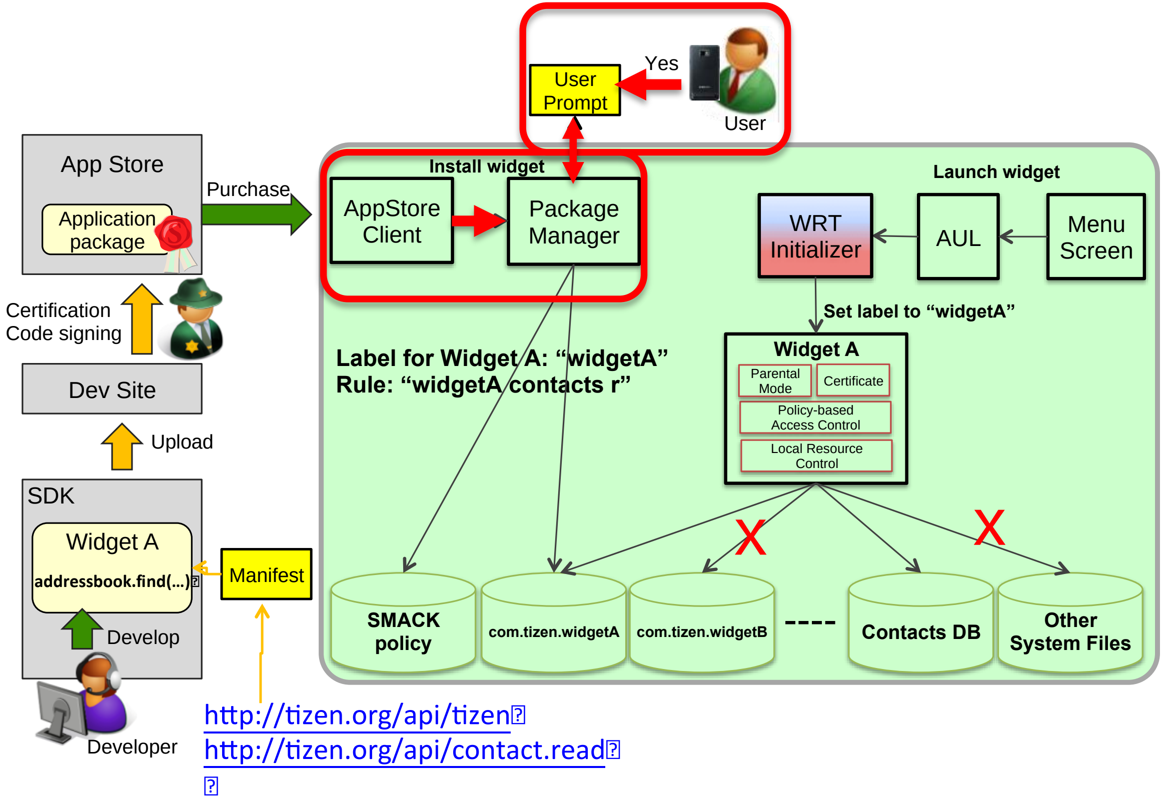

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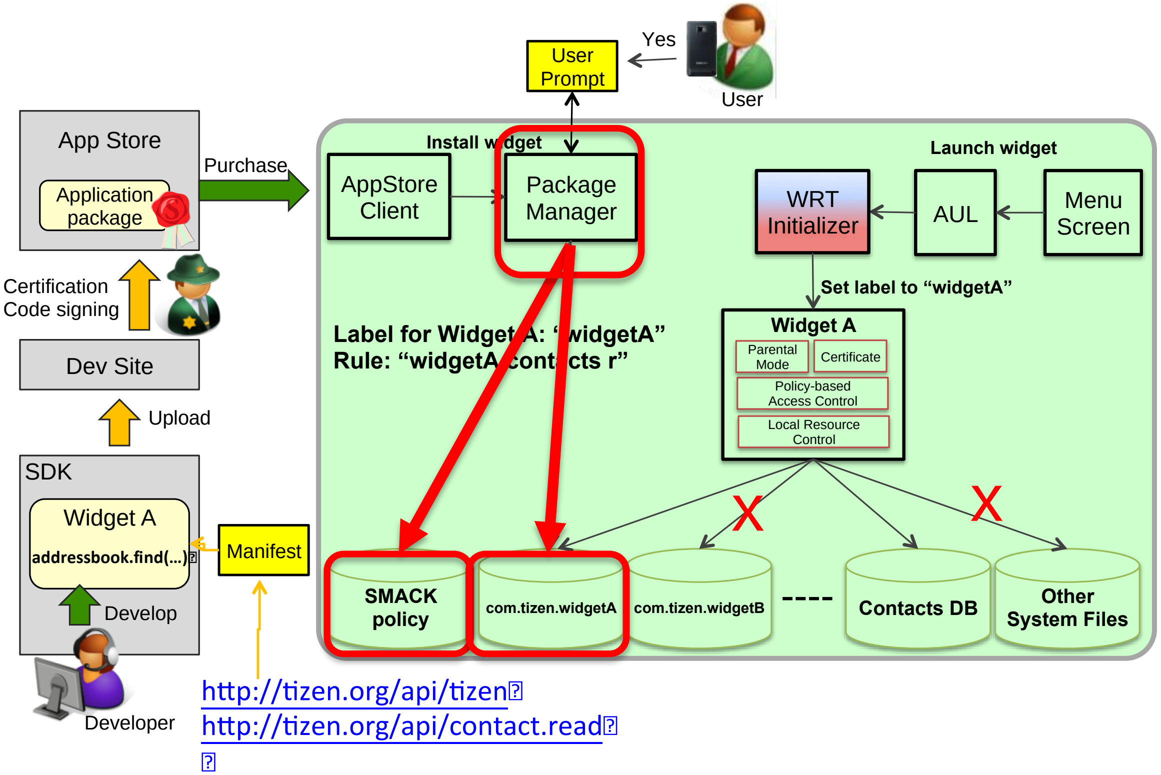

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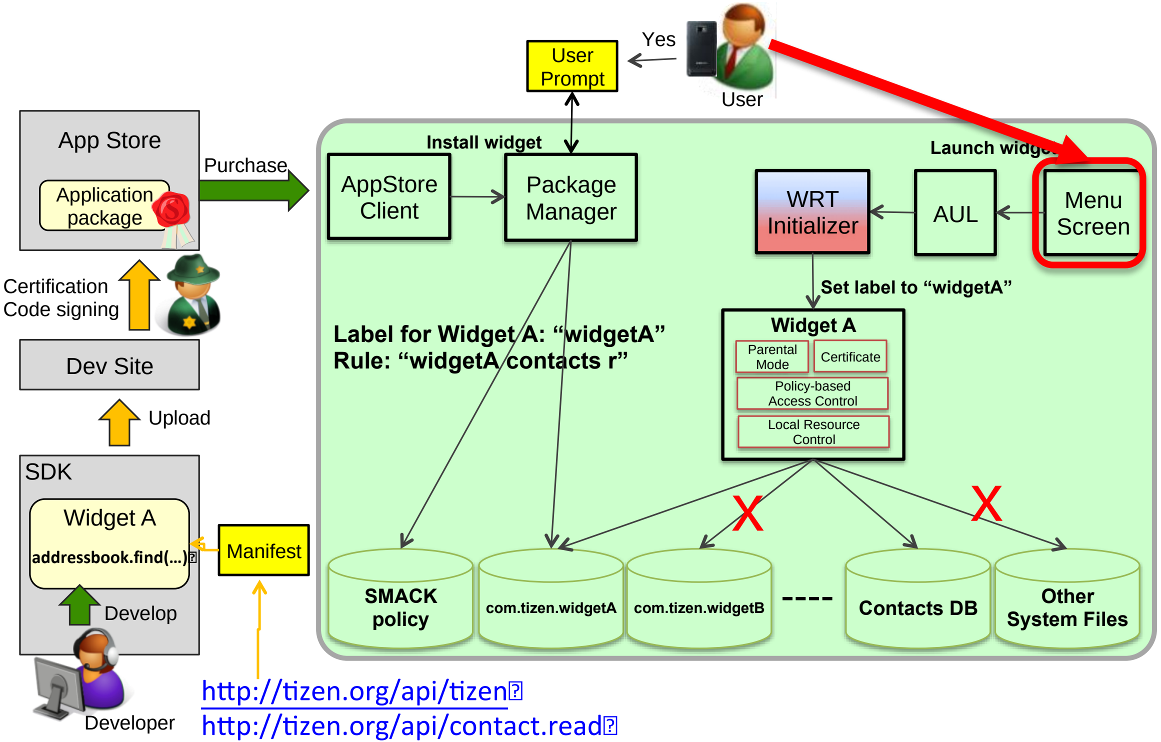

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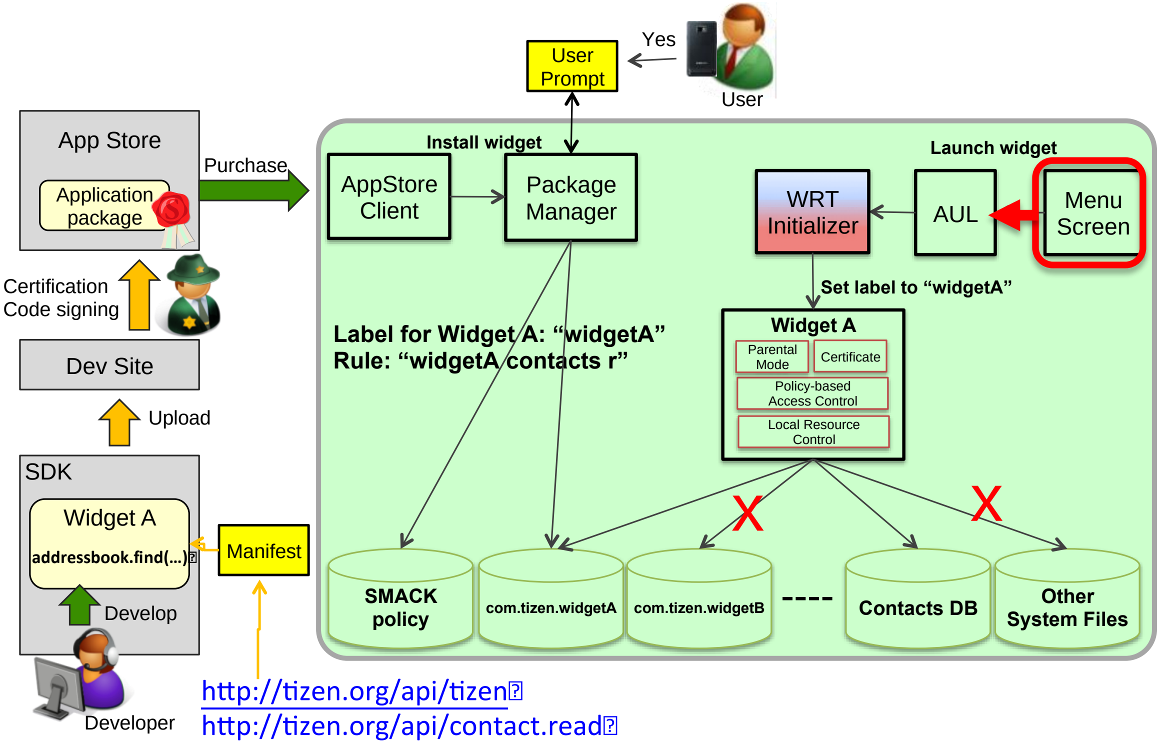

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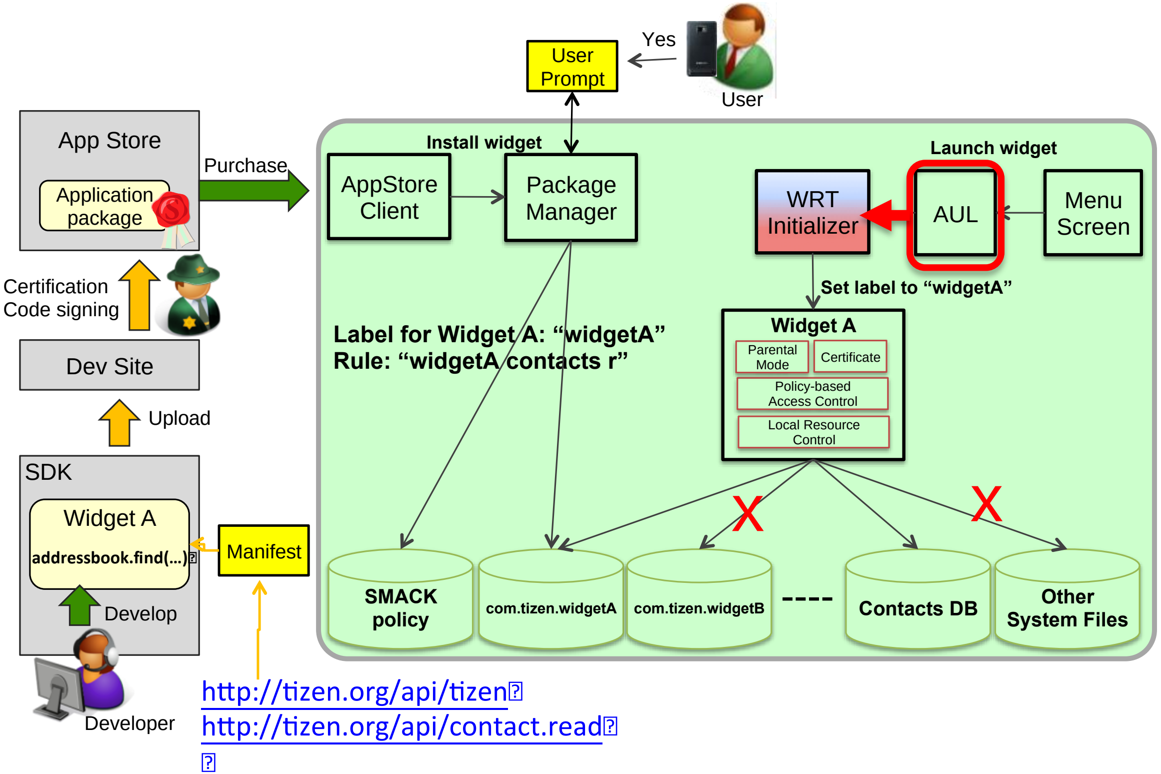

Access Control Enforcements on Tizen WebApps

- **SMACK Sandbox Example Flow:**
  - Widget A contains this code snippet

```
…
addressbook =
tizen.contact.getDefaultAddressBook();
addressbook.find(…);
…
```

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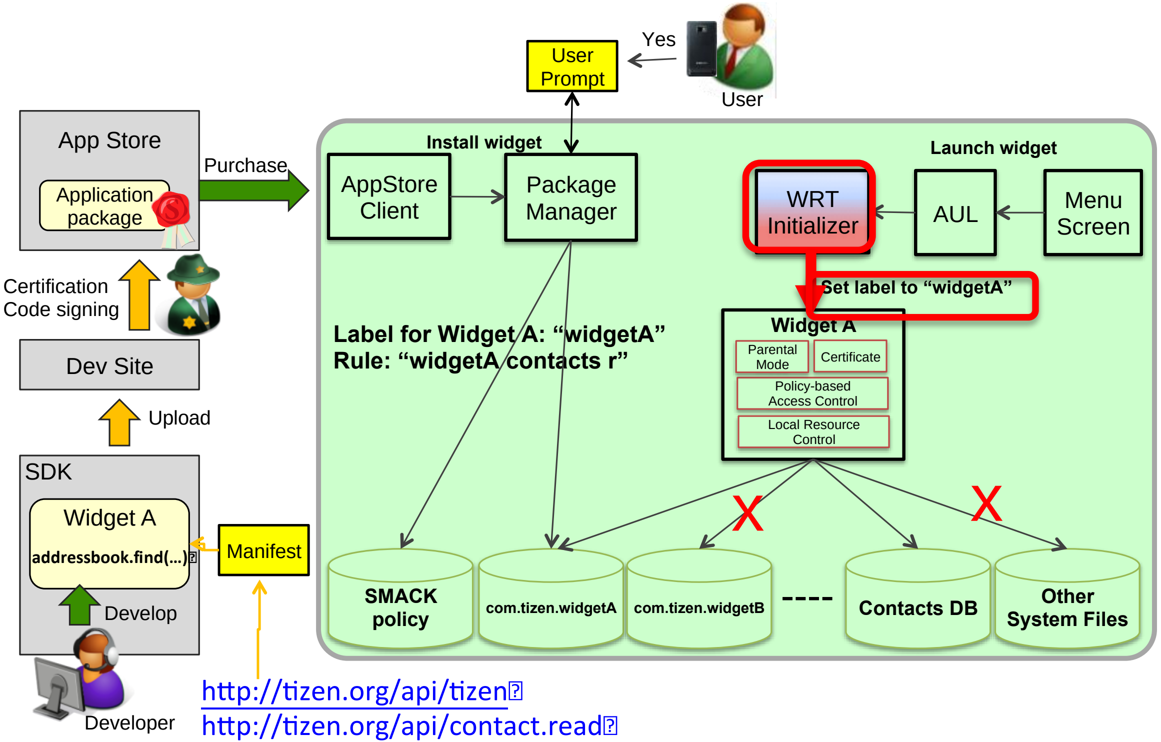

http://tizen.org/api/tizen
http://tizen.org/api/contact.read

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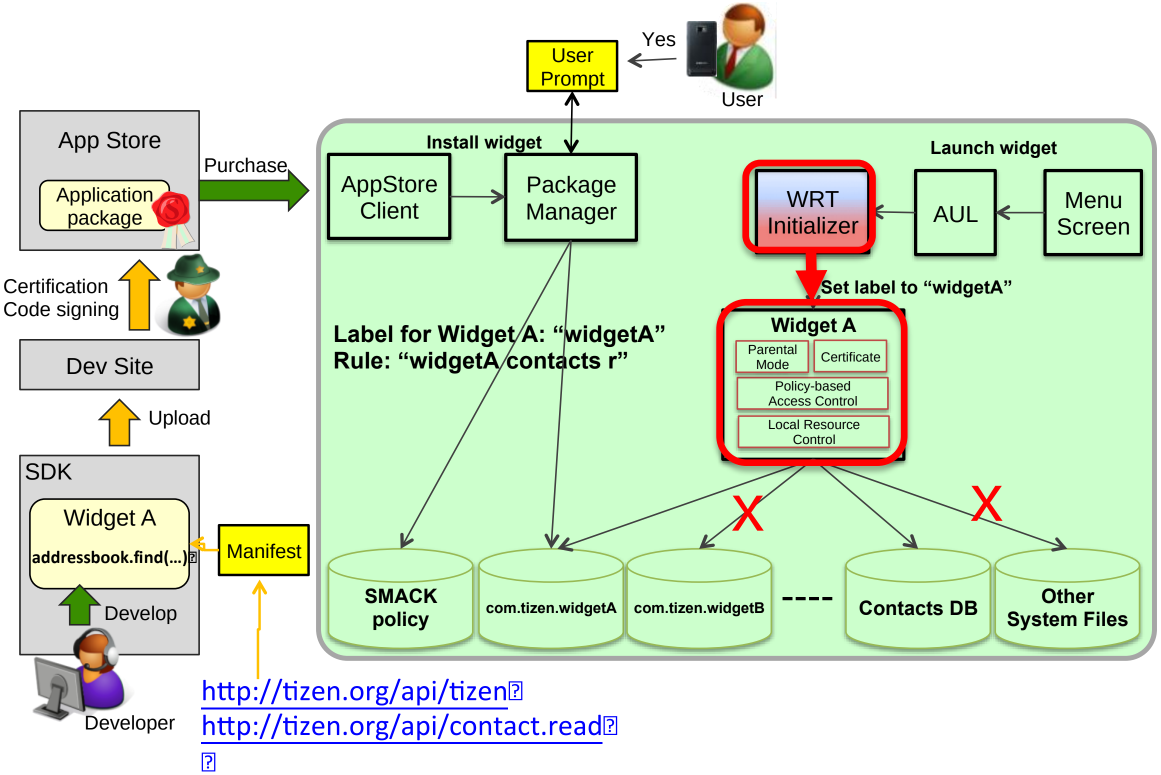

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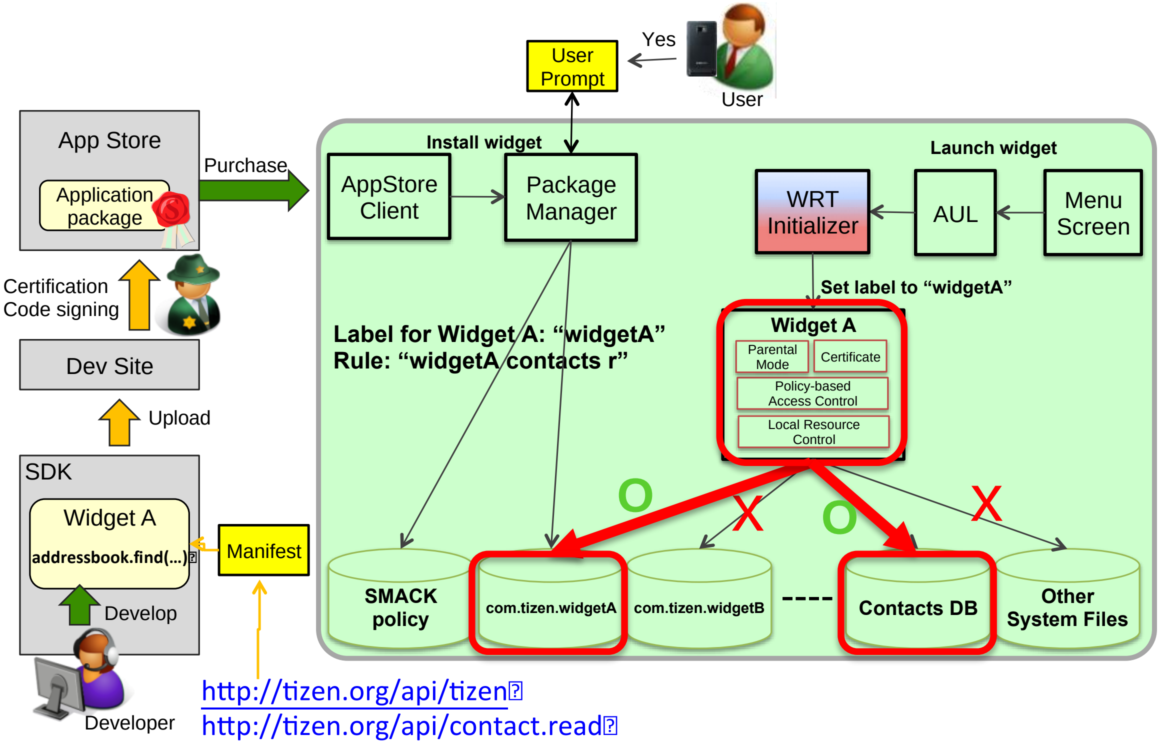

http://tizen.org/api/tizen

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Conclusions

- To developers:
  - You need to declare the required features in the manifest
    - The current SDK does not support automatic manifest configuration
    - Features need to be defined manually
  - Declare the minimum set of features you really need
    - Helps to better protect the device and user data
  - Pay attention to proper error handling in your application
    - Calls to device features may be denied by the Security system
    - Never assume a call will succeed

Thank You!

More Developer Information:

http://tizen.org

https://developer.tizen.org/documentation

Appendix Tizen APIs

API Group	Feature / Device Capability
Tizen	http://tizen.org/api/tizen
Alarm	http://tizen.org/api/alarm http://tizen.org/api/alarm.read http://tizen.org/api/alarm.write
Application	http://tizen.org/api/application http://tizen.org/api/application.read http://tizen.org/api/application.kill http://tizen.org/api/application.launch
Bluetooth	http://tizen.org/api/bluetooth http://tizen.org/api/bluetooth.spp http://tizen.org/api/bluetooth.gap
Calendar	http://tizen.org/api/calendar
	http://tizen.org/api/calendar.write
	http://tizen.org/api/calendar.read

API Group	Feature / Device Capability
Call	http://tizen.org/api/call http://tizen.org/api/call.simple http://tizen.org/api/call.history http://tizen.org/api/call.history.read http://tizen.org/api/call.history.write
Contact	http://tizen.org/api/contact http://tizen.org/api/contact.read http://tizen.org/api/contact.write
Filesystem	http://tizen.org/api/filesystem
	http://tizen.org/api/filesystem.read
	http://tizen.org/api/filesystem.write
Geocoder	http://tizen.org/api/geocoder

Appendix Tizen APIs

API Group	Feature / Device Capability
Media Content	http://tizen.org/api/mediacontent http://tizen.org/api/mediacontent.read
Messaging	http://tizen.org/api/messaging http://tizen.org/api/messaging.send http://tizen.org/api/messaging.read http://tizen.org/api/messaging.write
NFC	http://tizen.org/api/nfc http://tizen.org/api/nfc.tag http://tizen.org/api/nfc.p2p http://tizen.org/api/nfc.se
SystemInfo	http://tizen.org/api/systeminfo
Time	http://tizen.org/api/time http://tizen.org/api/time.read http://tizen.org/api/time.write
LBS Map POI Route	 http://tizen.org/api/lbs.map http://tizen.org/api/lbs.poi http://tizen.org/api/lbs.route

Developer Information:
https://developer.tizen.org/documentation