Android Nougat

Nougat New Features

1. Android Nougat makes updates faster and easier
2. **Multi-window multitasking**
3. **Even better notifications**
4. **Your phone will feel faster and use less battery**
5. **More human emoji**
6. **Improved security**
7. **Android TV recording and Picture-in-Picture**

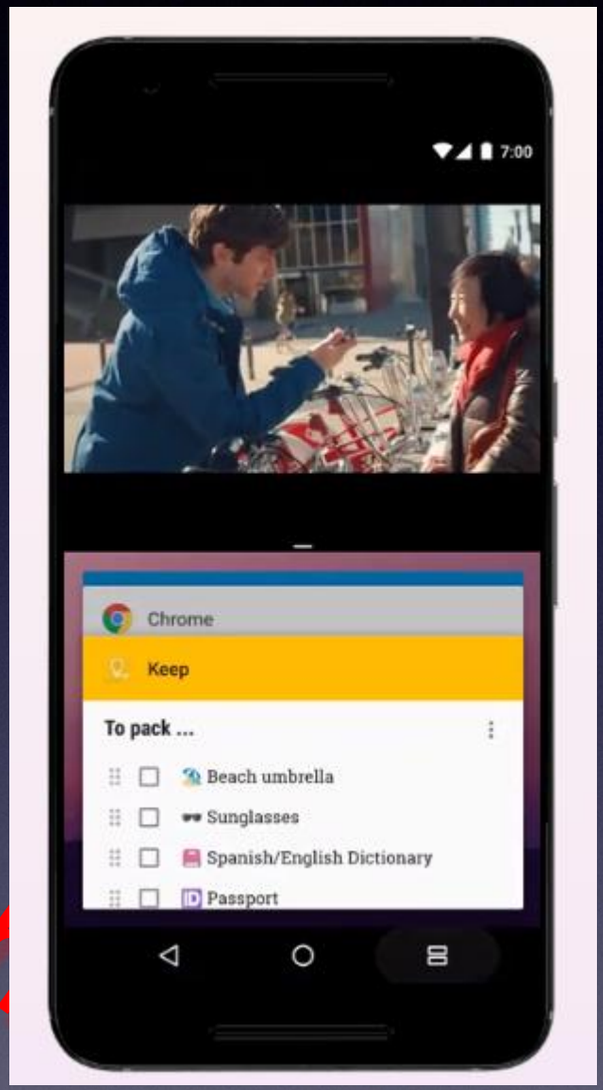
1 Seamless Updates

“Android Nougat also adds some important new features to help keep users safer and more secure. Inspired by how Chromebooks apply updates, we‘re introducing seamless updates, so that new Android devices built on Nougat can install system updates in the background. This means that the next time a user powers up their device, new devices can automatically and seamlessly switch into the new updated system image.”

- Seamless updates work by having two different system partitions on your phone.
- This will use more space on your phone's internal storage.

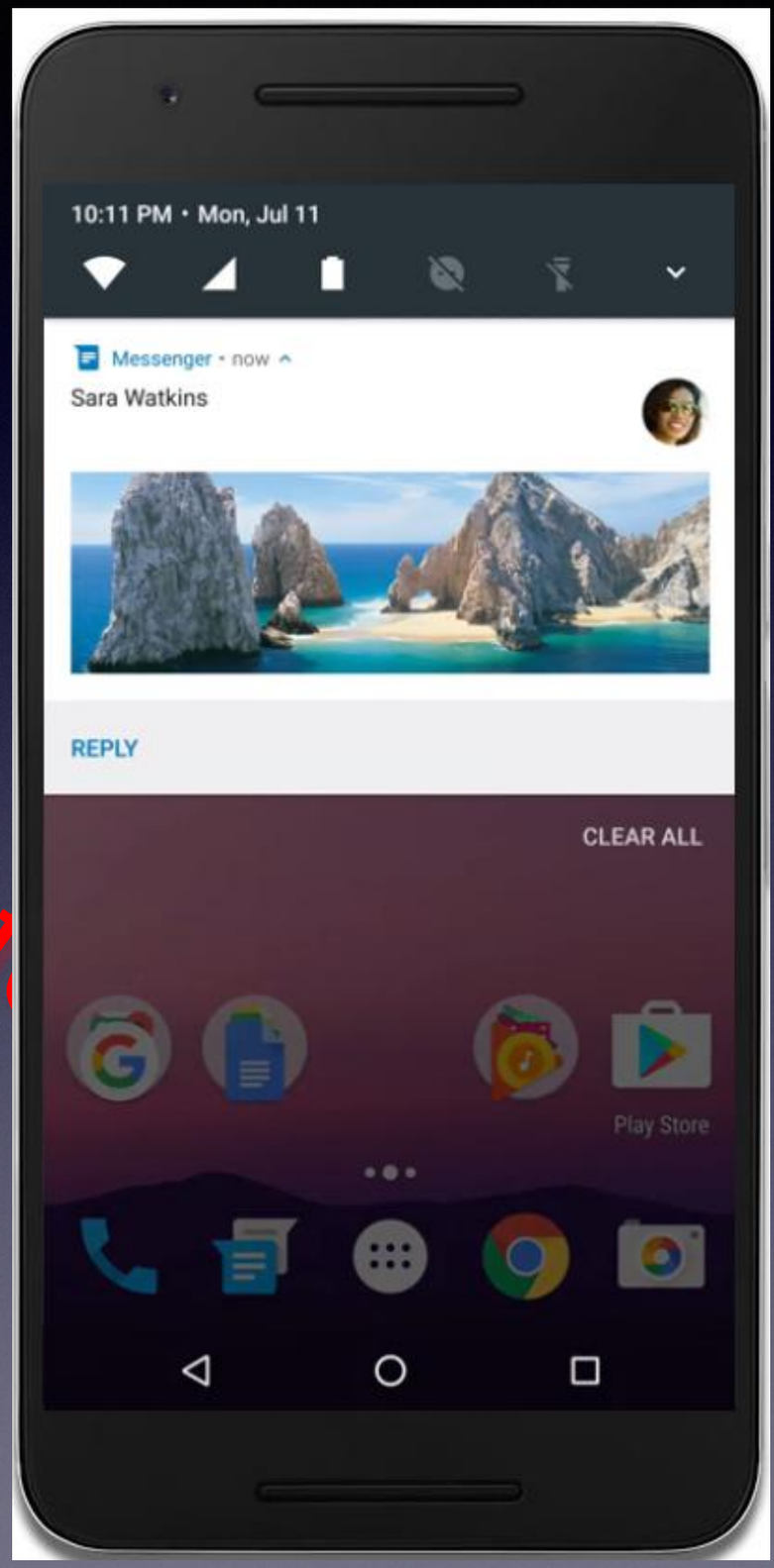
2 Multi-window for everyone

- **Split-screen view ----**designed for handheld devices
- **picture-in-picture mode** --make Android TV better
- **freeform mode** --- now only officially exists in the documentation. It puts apps into floating windows than can be resized, moved around, minimized or maximized.



3 Better and more interactive notifications

- **Direct Replies ----**designed for handheld devices
- **Bundled Notifications -** can be bundled together into a single group for a single app
- **Notification Peeking--** reply to each individual message thread
- **Custom Views and Message Styles**



4 Better performance, longer battery life

- network changes -- When targeted towards Android 7.0, apps can only listen for network changes through the main thread (what runs when the app is awake and you're using it) so they aren't waking up every time you switch networks.
- picture or video to be taken -- In Android 7.0, the new picture and new video broadcasts can't be sent. That means even if developers don't update existing apps, they'll never be told to wake up when a picture or video is taken.

5 More human emoji

- In addition to 72 new glyphs, Android 7.0 has over 1,500 emoji, many of which have been revamped to look a bit more.... human. Traditionally, Android emoji have been cartoony, which has encouraged other manufacturers like Samsung and LG to write their own.

6 Improved security

- **Direct Boot**

- 1 Credential encrypted storage:
- **2** Device encrypted storage **---** lock screen

- **Only granting permission to the folders**

With Android Nougat, you can give an app access to a certain folder (like your picture library) without letting it have access to all of your external (SD card) storage.

7 Language and locale

- Android N is the first version that can dynamically load more than one language on the device, switching between the two easily.
- The feature, called Multi-Locale, allows users to set up a list of languages that can easily be re-ordered in a list.

8 Android TV recording and Picture-in-Picture

Better recording

- You'll be able to record live shows and save them for later, schedule a recording and have multiple recordings saved on your TV at once.

Picture-in-picture

- This is an extension of Android 7.0's multi-window display that can put an application's viewable portion into a 240x135dp (dot pitch) top-layer window

TIF：Android TV Input Framework

frameworks/base/media/java/android/media/tv
frameworks/base/services/core/java/com/android/server/tv/
hardware/realtek/tv_input
device/realtek/frameworks/base/tvsystem

Android TV

Big screen apps, games, and content

Recommend great content to users right on the home screen. Enable users to find movies through voice search. Engage users with fluid, immersive games.

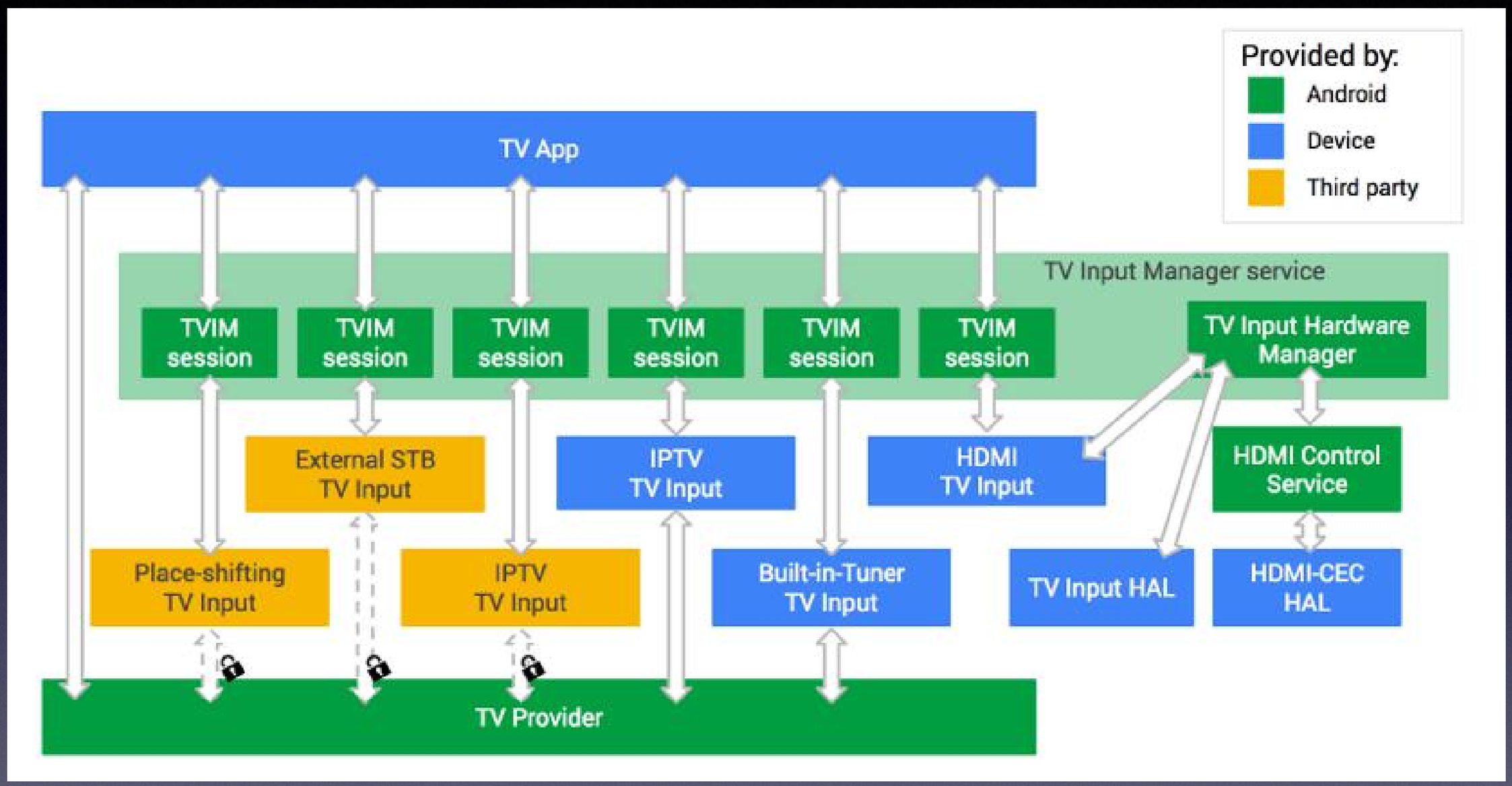
The upcoming Android O release introduces the new Android TV home screen that organizes video content into channels and programs in a way that's familiar to TV viewers. Read about it on the **Android O Preview Page** and watch the **I/O 2017 Android TV session**.

GET STARTED

Less browsing, more watching

Apps like YouTube, Hulu Plus and NBA Game Time put personalized recommendations for videos, shows and sports in your home screen.

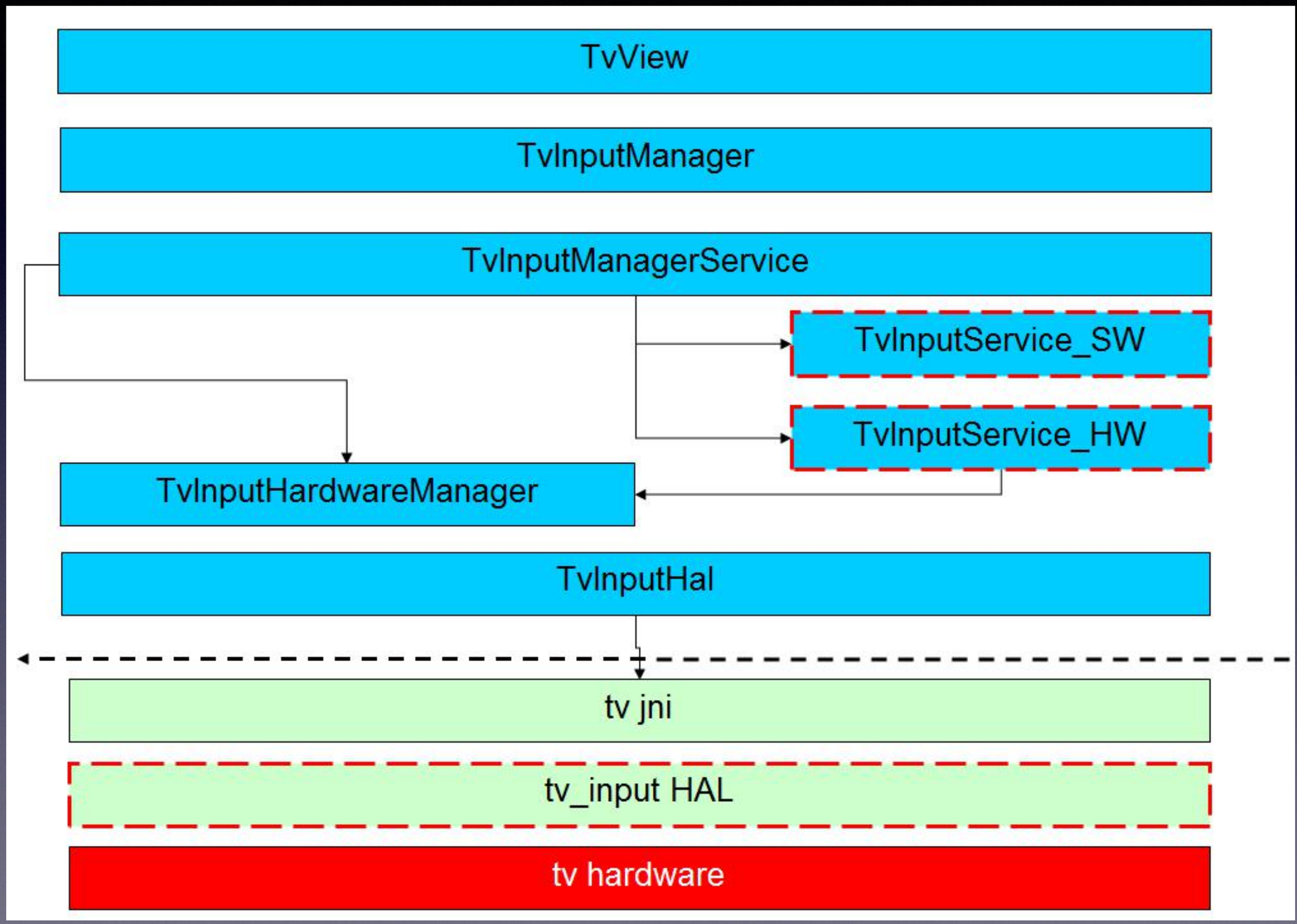
Android TV Input Framework (TIF) architecture



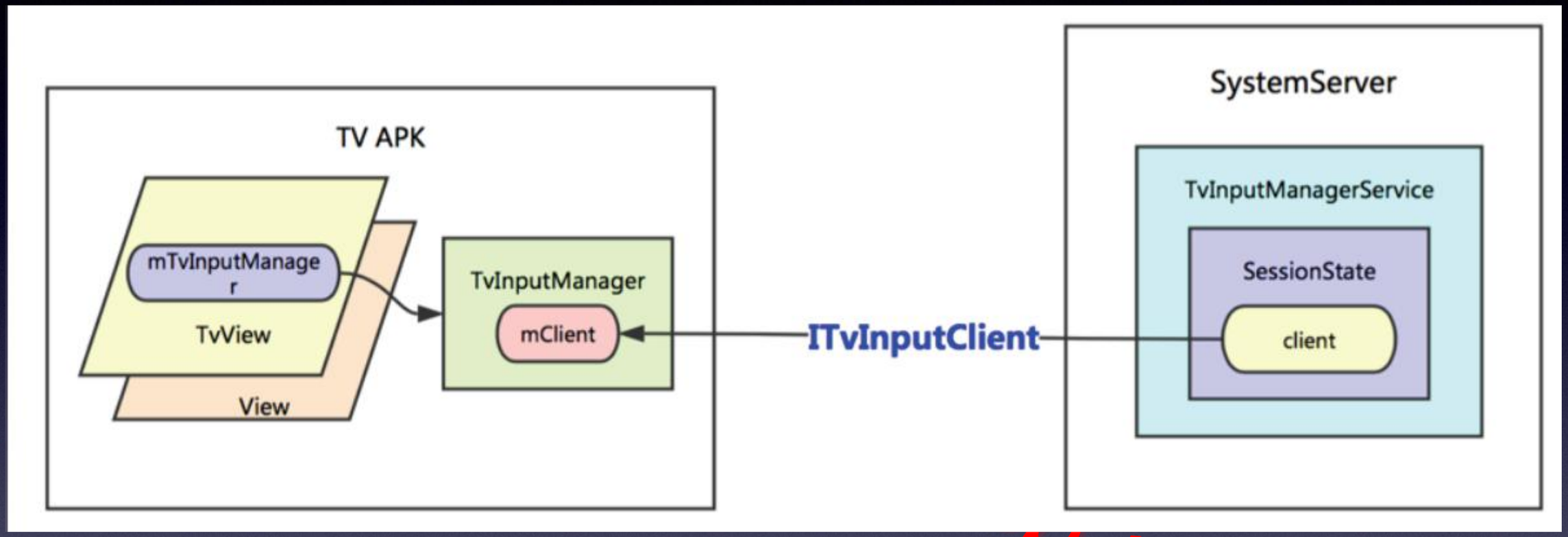
Flow

- The user sees and interacts with the TV App, a system app that can't be replaced by a third-party app.
- The TV App displays the AV content from the TV Input.
- The TV App cannot talk directly with the TV Inputs. The TV Input Manager identifies the state of TV Inputs for the TV App.

TV Input Manager



TV Input Manager



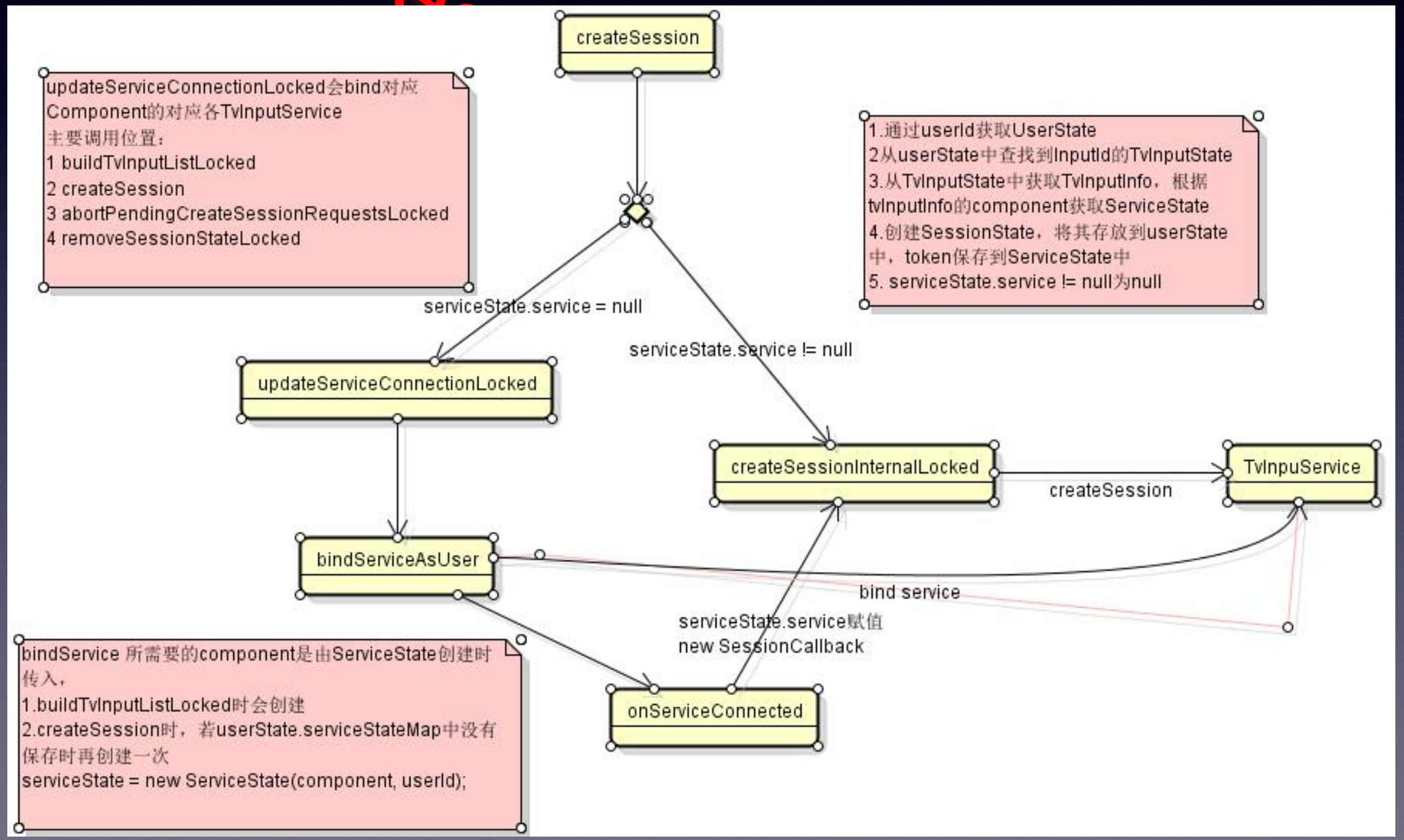
The TV Input Manager provides a central system API to the overall Android TV Input Framework.

- List TV inputs and check their status
- Create sessions and manage listeners

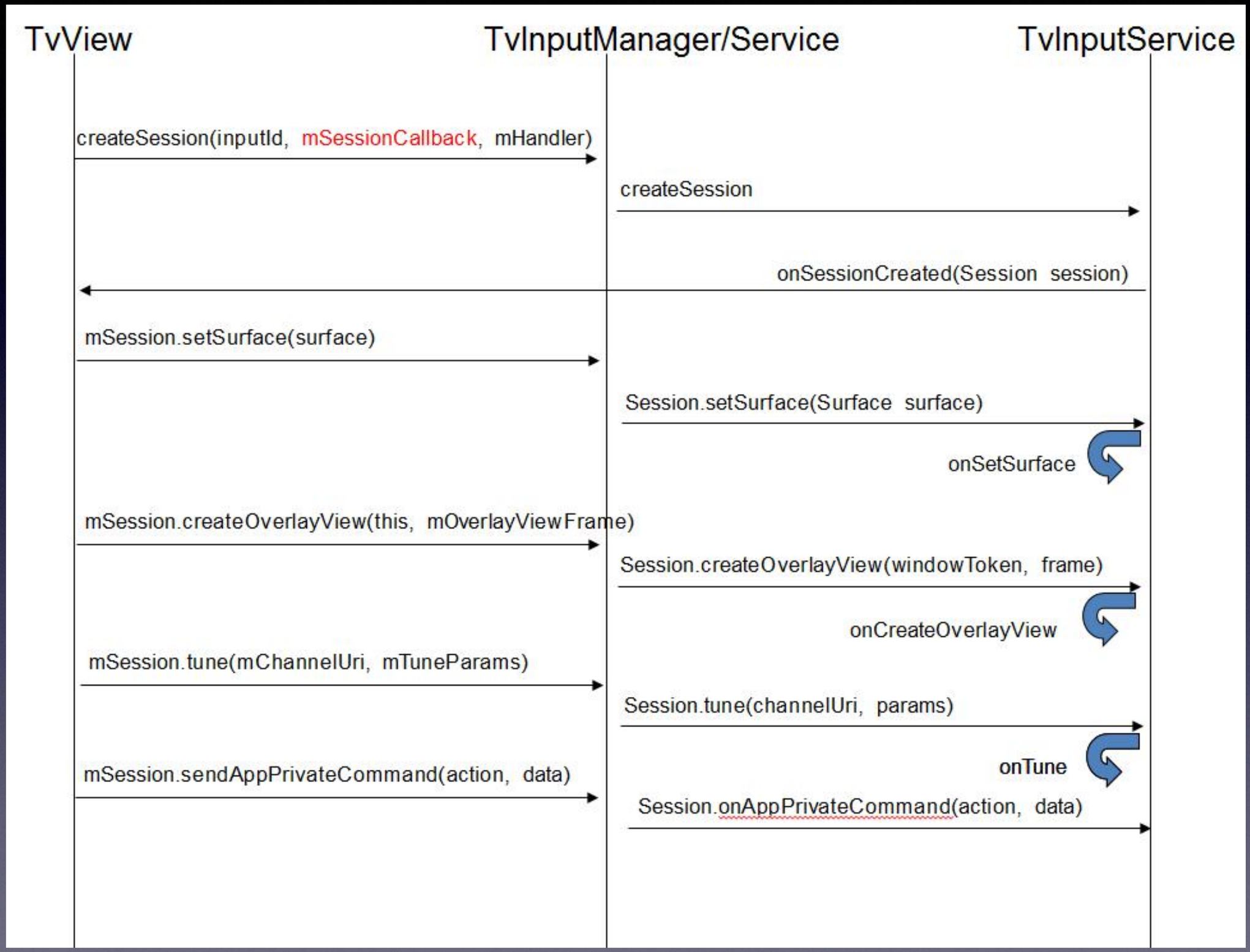
The TV Input Manager abstracts communication between the TV App and TV Inputs.

TV Input Manager

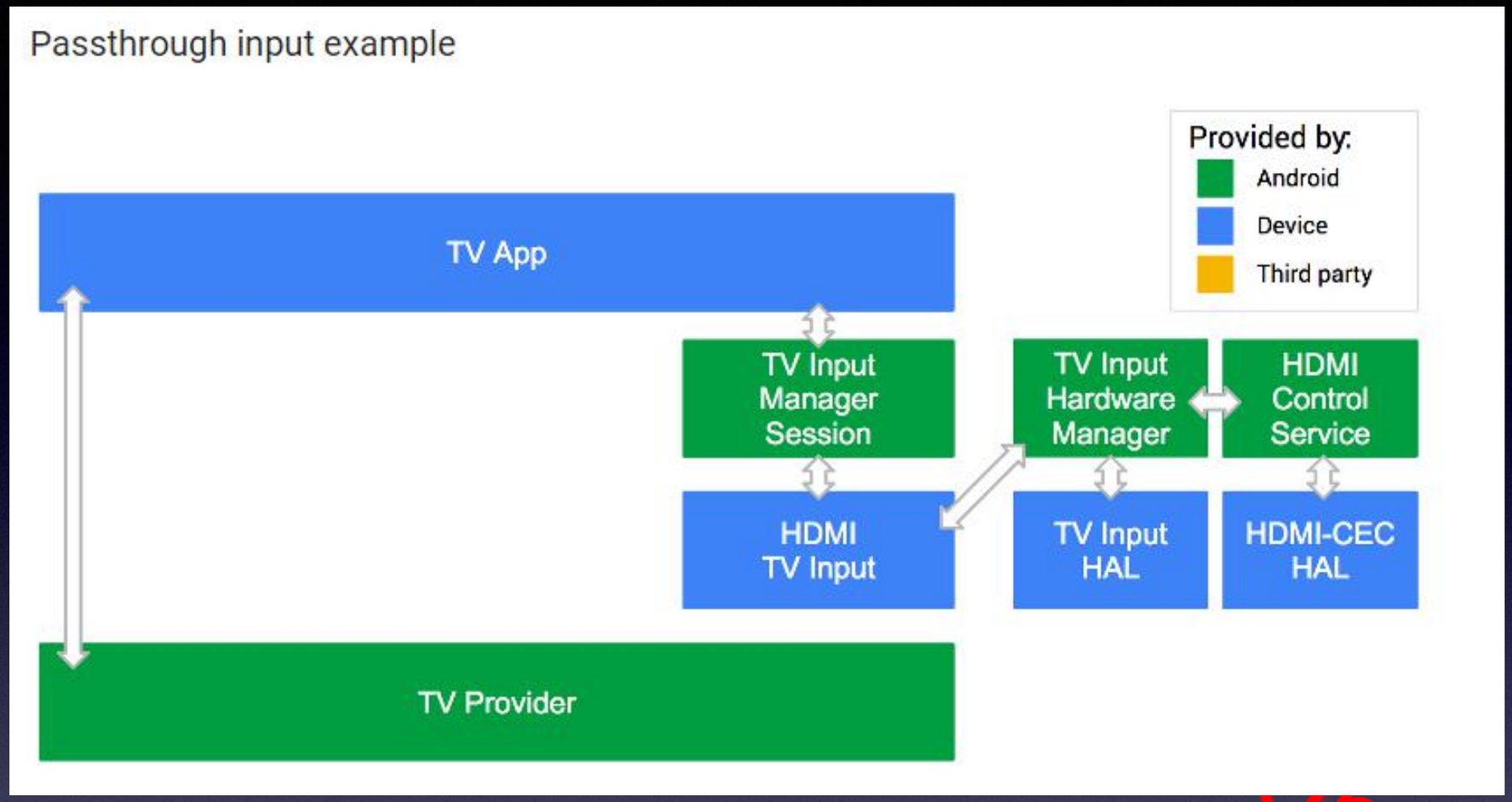
TvInputManagerService.java createSession 过程



TV Input Manager



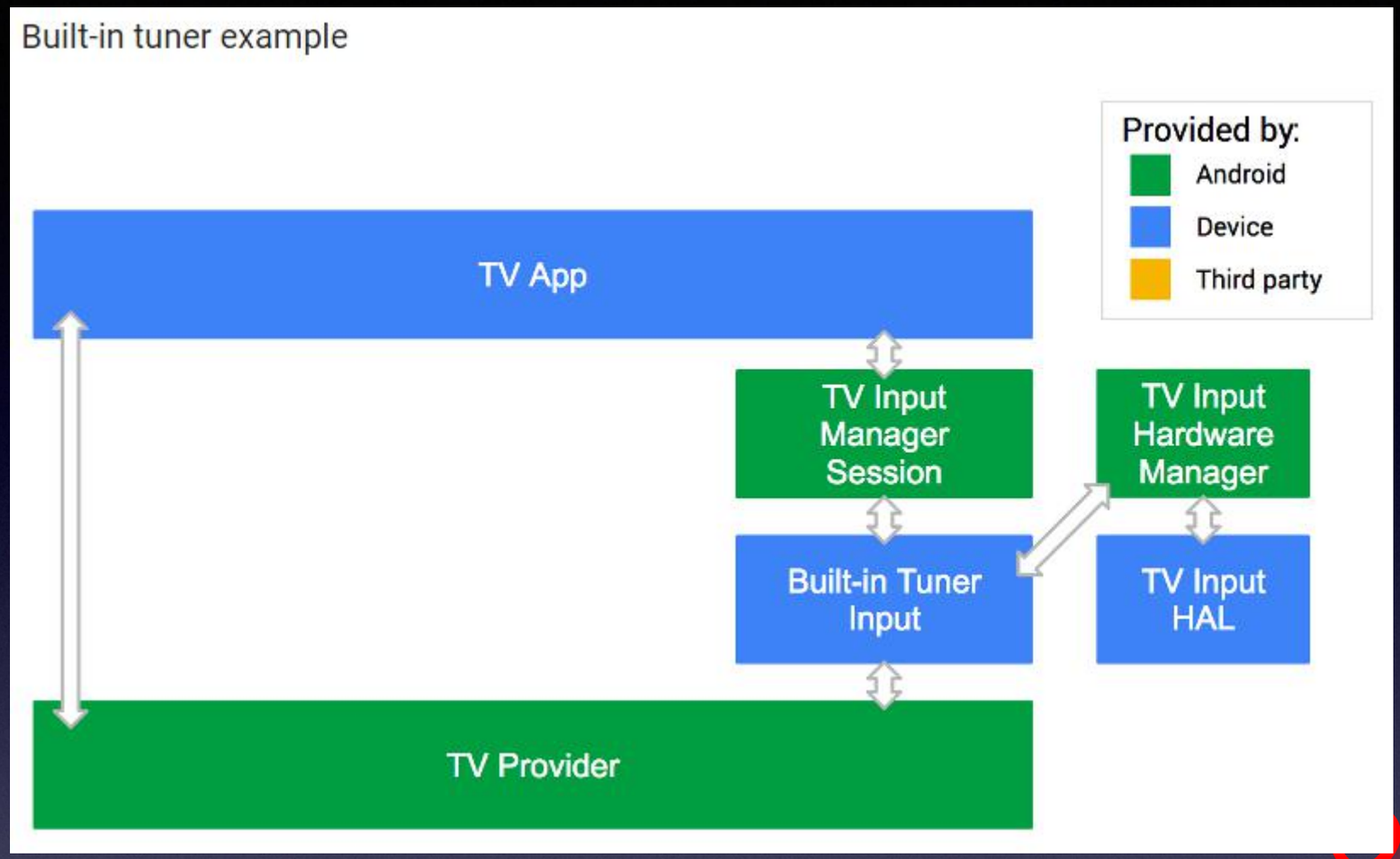
TV Inputs



- As a passthrough TV Input, it does not register any channels or programs with the TV Provider.

- To obtain the URI used to reference the passthrough input, use the android.media.tv.TvContract utility method buildChannelUriForPassthroughInput(String inputId).

TV Inputs

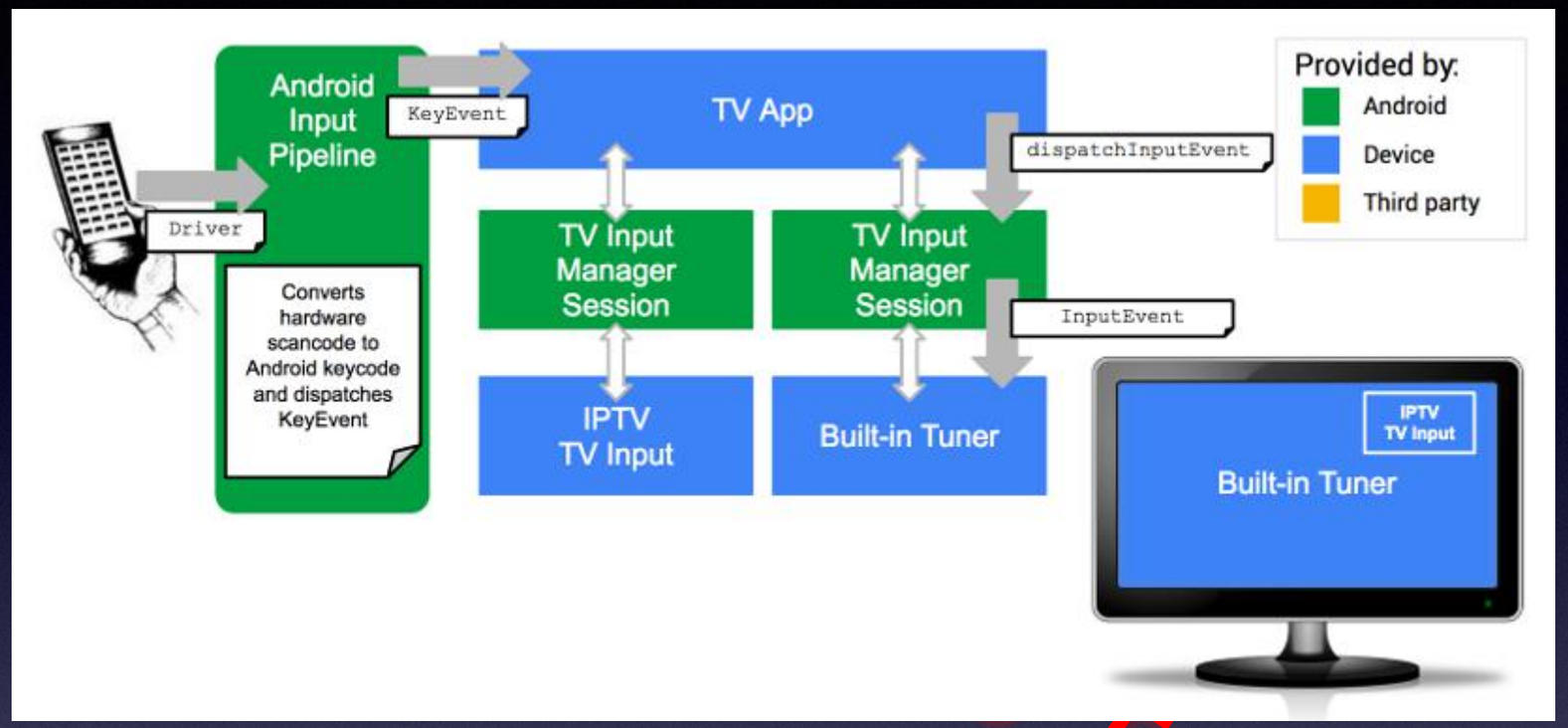


- The Built-in Tuner TV Input provided by the device manufacturer is trusted and has full access to the TV Provider.
- DTV/ATV is Tunner Tv Input

```
TV input type: the TV input service is a tuner which provides
lic static final int TYPE_TUNER = 0;
TV input type: a generic hardware TV input type.
lic static final int TYPE_OTHER = 1000;
TV input type: the TV input service represents a composite port
lic static final int TYPE_COMPOSITE = 1001;
TV input type: the TV input service represents a SVIDEO port.
lic static final int TYPE_SVIDEO = 1002;
TV input type: the TV input service represents a SCART port.
lic static final int TYPE_SCART = 1003;
TV input type: the TV input service represents a component port
lic static final int TYPE_COMPONENT = 1004;
TV input type: the TV input service represents a VGA port.
lic static final int TYPE_VGA = 1005;
TV input type: the TV input service represents a DVI port.
lic static final int TYPE_DVI = 1006;
TV input type: the TV input service is HDMI. (e.g. HDMI 1)
lic static final int TYPE_HDMI = 1007;
TV input type: the TV input service represents a display port.
lic static final int TYPE_DISPLAY_PORT = 1008;
```

TV Inputs

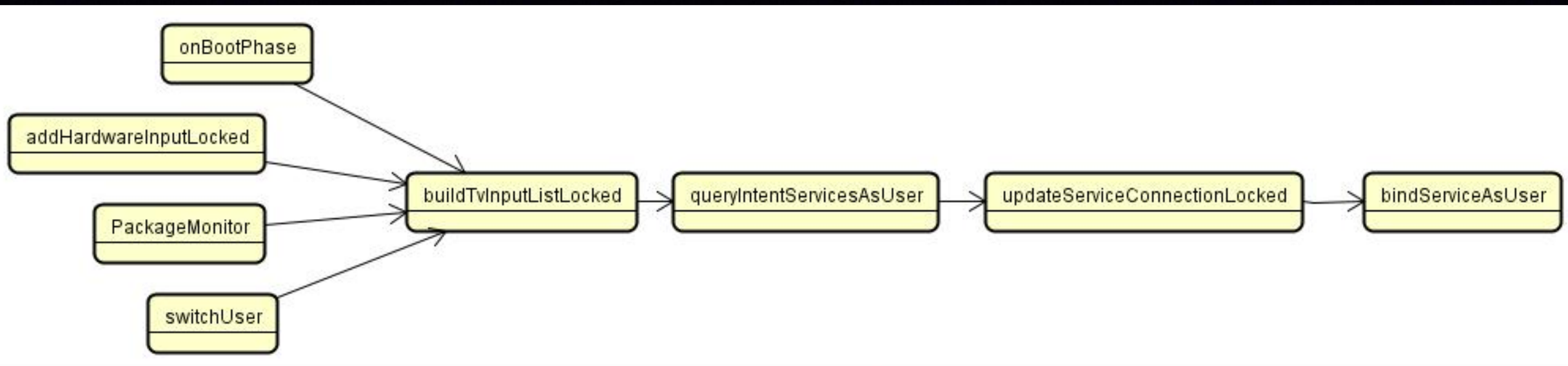
Android TV KeyEvents



- Passing keycodes to the standard Android input pipeline InputReader and InputDispatcher functions as KeyEvents.
- Only system TV Inputs are eligible to receive InputEvents, and only if they have the RECEIVE_INPUT_EVENT system permission.
- The TV Input is responsible to determine which InputEvents to consume and should allow the TV App to handle the keys it does not need to consume.

TV Inputs

tvinput启动过程

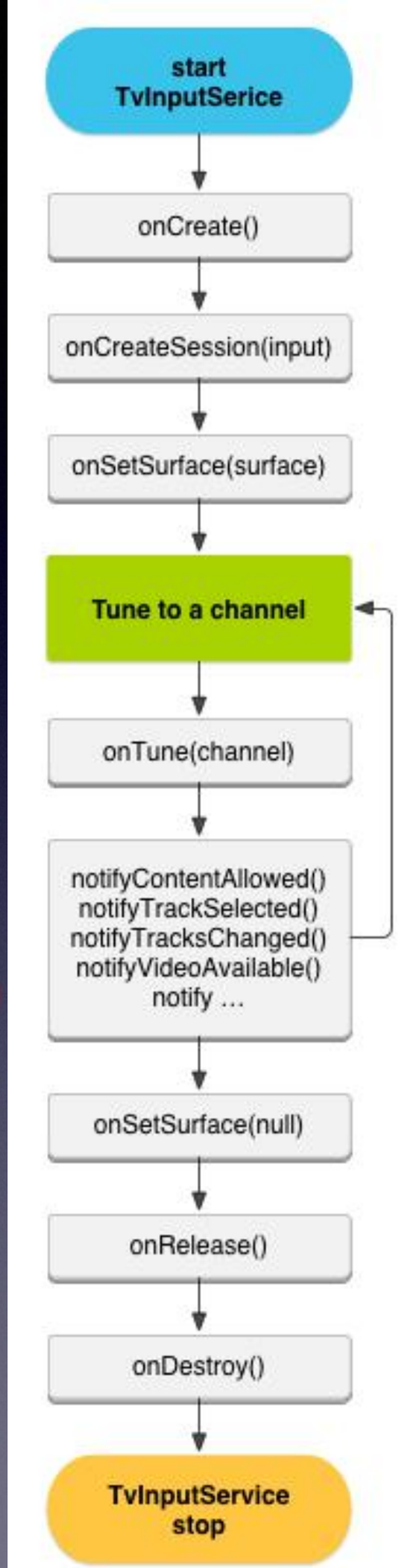


TvInputManagerService启动后，
在四个阶段都会重新build tvinput：

- onBootPhase：
SystemService.PHASE_THIRD_PARTY_APPS_CAN_START
- addHardwareInput：hardware 的input添加成功后
- PackageMonitor：PHASE_SYSTEM_SERVICES_READY 时添加PackageMonitor，新安装卸载会重新build
- switchUser：接受到ACTION_USER_SWITCHED时会触发

TV Inputs

TvInputService lifecycle



TV Inputs

Define your TvInputService

```
<service android:name=" com.realtek.dtv.tvinput.DTVTvInputService"
   android:label="@string/dtv_app_name"
   android:permission="android.permission.BIND_TV_INPUT">
   <!-- Required filter used by the system to launch our account service.-->
   <intent-filter>
      <action android:name="android.media.tv.TvInputService" />
   </intent-filter>
   <!-- An XML file which describes this input. This provides pointers to
   the Activity to the system/TV app. -->
   <meta-data
      android:name="android.media.tv.input"
      android:resource="@xml/dtv_tvinputservice" />
</service>
```


Define your setup activity

```
<tv-input xmlns:android="http://schemas.android.com/apk/res/android"
   android:setupActivity="com.realtek.dtv.DigitalSetup.DigitalChannelSetupActivity"
   android:canRecord="true"
   android:tunerCount="2"/>
```

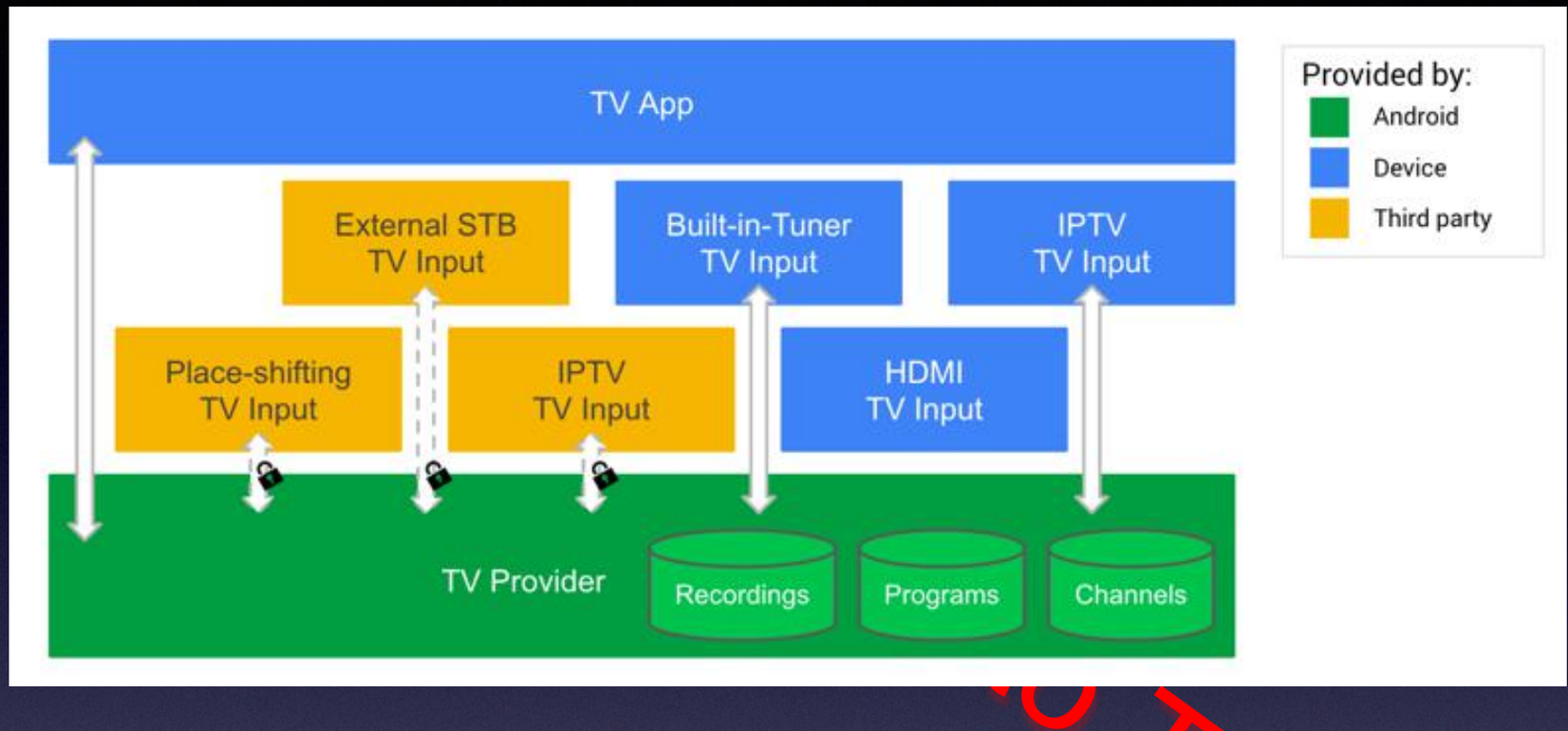
TV Inputs

Create a TV Input Service Using the TV Input Framework

If your TV input service can't use the TIF Companion Library, you need to implement the following components:

- TvInputService provides long-running and background availability for the TV input
- TvInputService.Session maintains the TV input state and communicates with the hosting app
- TvContract describes the channels and programs available to the TV input
- TvContract.Channels represents information about a TV channel
- TvContract.Programs describes a TV program with data such as program title and start time
- TvTrackInfo represents an audio, video, or subtitle track
- TvContentRating describes a content rating, allows for custom content rating schemes
- TvInputManager provides an API to the system TV app and manages the interaction with TV inputs and apps

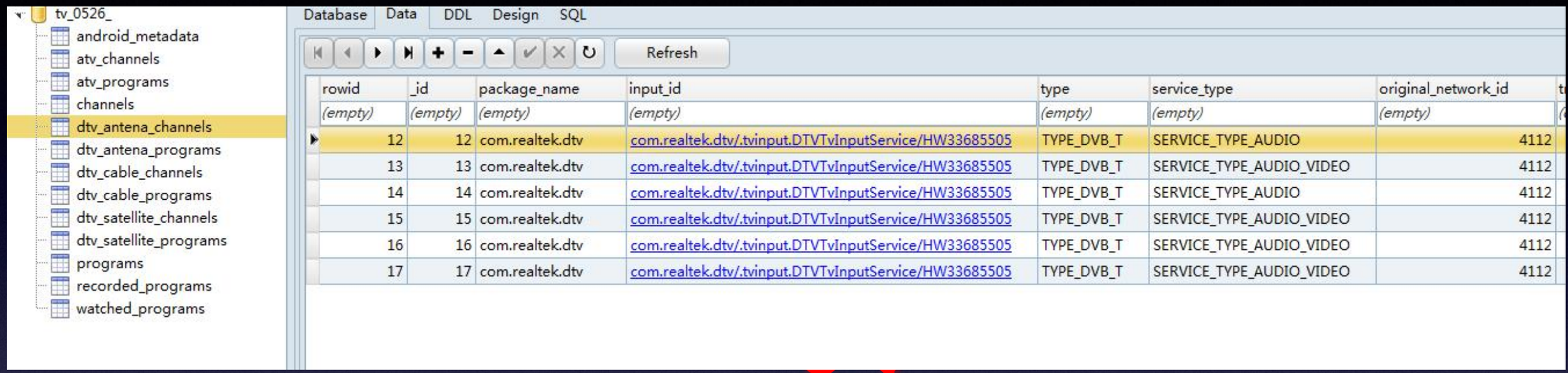
TV Provider



- The TV Provider database stores the channels and programs from TV Inputs.
- The TV Provider supports structured data in channel (android.provider.TvContract.Channels) and program (android.provider.TvContract.Programs) tables.

TV Provider

```
RealtekATV:/data/data/com.android.providers.tv/databases # ls -la
total 528
drwxrwx--x 2 u0_a2 u0_a2   4096 2017-07-16 02:00 .
drwx------ 6 u0_a2 u0_a2   4096 2017-07-16 02:00 ..
-rw-rw---- 1 u0_a2 u0_a2 204800 2013-01-01 01:07 tv.db
-rw------- 1 u0_a2 u0_a2  45656 2013-01-01 01:07 tv.db-journal
```



rowid	_id	package_name	input_id	type	service_type	original_network_id
(empty)	(empty)	(empty)	(empty)	(empty)	(empty)	(empty)
12	12	com.realtek.dtv	com.realtek.dtv/.tvinput.DTVTvInputService/HW33685505	TYPE_DVB_T	SERVICE_TYPE_AUDIO	4112
13	13	com.realtek.dtv	com.realtek.dtv/.tvinput.DTVTvInputService/HW33685505	TYPE_DVB_T	SERVICE_TYPE_AUDIO_VIDEO	4112
14	14	com.realtek.dtv	com.realtek.dtv/.tvinput.DTVTvInputService/HW33685505	TYPE_DVB_T	SERVICE_TYPE_AUDIO	4112
15	15	com.realtek.dtv	com.realtek.dtv/.tvinput.DTVTvInputService/HW33685505	TYPE_DVB_T	SERVICE_TYPE_AUDIO_VIDEO	4112
16	16	com.realtek.dtv	com.realtek.dtv/.tvinput.DTVTvInputService/HW33685505	TYPE_DVB_T	SERVICE_TYPE_AUDIO_VIDEO	4112
17	17	com.realtek.dtv	com.realtek.dtv/.tvinput.DTVTvInputService/HW33685505	TYPE_DVB_T	SERVICE_TYPE_AUDIO_VIDEO	4112

Table：
Atv -- channel/program
dtv-antena/dtv-cable/dtv-satellite -- channel/program
Channels/programs(存放google channel等原生的channel info)
Recorded_program(dvr file)
Watched_program(目前仅能存放channels table中的记录)

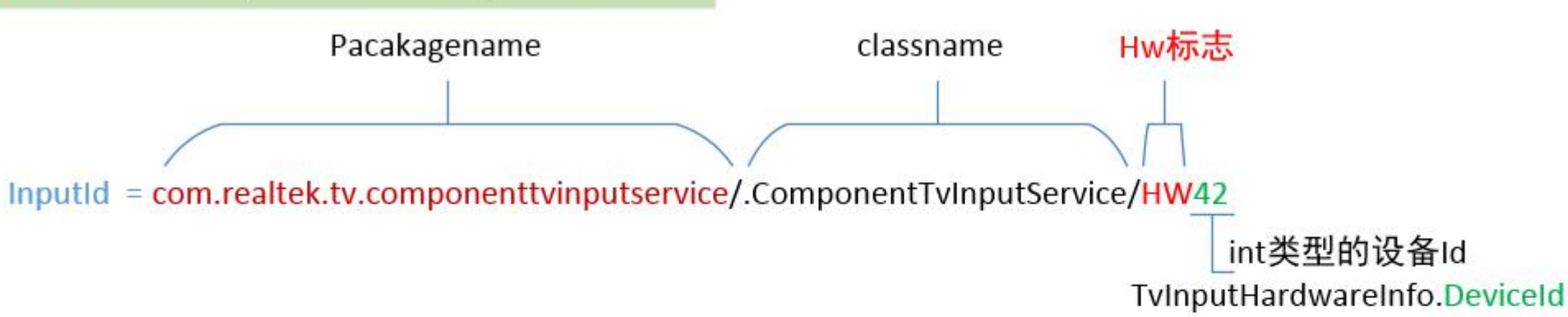
Table Column definitions ：
android/frameworks/base/media/java/android/media/tv/TvContract.java
device/realtek/frameworks/base/tvsystem/java/com/realtek/tv/TvContractEx.java

TV Provider

Channels
CONTENT_URI = Uri.parse("content://" + AUTHORITY + "/“ + PATH_CHANNEL);

buildChannelUri： tuner channel（atv/dtv）
buildChannelUriForPassthroughInput（hdmi/av/ypp）

TvInputInfo.createTvInputInfo是构建InputId原理：



TvContract.buildChannelUriForPassthroughInput原理：

TV Provider

Permissions

•Each row has PACKAGE_NAME, the package (app) that owns that row, checked on Query, Insert, Update via TvProvider.java. A TV Input may access only the information it wrote and is cordoned off from the information provided by other TV Inputs.

•READ, WRITE permissions via AndroidManifest.xml (requires user consent) to determine available channels.

•Only signatureOrSystem apps can acquire ACCESS_ALL_EPG_DATA permission to access the entire database.

TvInputHal

TvInputHardManager

TIF对象的成员变量，用来管理底层TvInputhal硬件， TvInputHardwareManager向上可通知TIF和TvInputService硬件状态信息的变化， TvInputHardwareManager向下可通过TvInputHal访问硬件。

JTvInputHal

TvInputHal.java在JNI调用中作为Native层的总代理，负责完成传递实际的硬件设置和硬件状态回调通知功能；

onDeviceAvailable（）

onStreamConfigurationsChanged（）

onDeviceUnavailable（）

这些onXXX()函数都是JTvInputHal在消息循环中被调用，用于通知上层TIMS和TvInputService硬件状态信息的变化。

TvInputHal

Tv_input_rtdXX.so

由完成实际底层硬件设置和状态通知的实例tv_InputHal.cpp生成的动态链接库。在JTvInputHal的构造函数中被动态链接使用，其内部用一个Thread 通过notify( )函数往JTvInputHal的消息循环中投递消息，这样任何底层硬件的状态信息变化都可以通知到上层JTvInputHal和TIF ；

TvInputHal主要作用：
1 onHardwareAdded
2 与sufaceFilnger 进行交互设置

<uses-permission android:name="android.permission.TV_INPUT_HARDWARE" />

```
private static boolean hasHardwarePermission(PackageManager pm, ComponentName component) {
    return pm.checkPermission(android.Manifest.permission.TV_INPUT_HARDWARE,
            component.getPackageName()) == PackageManager.PERMISSION_GRANTED;
}
```

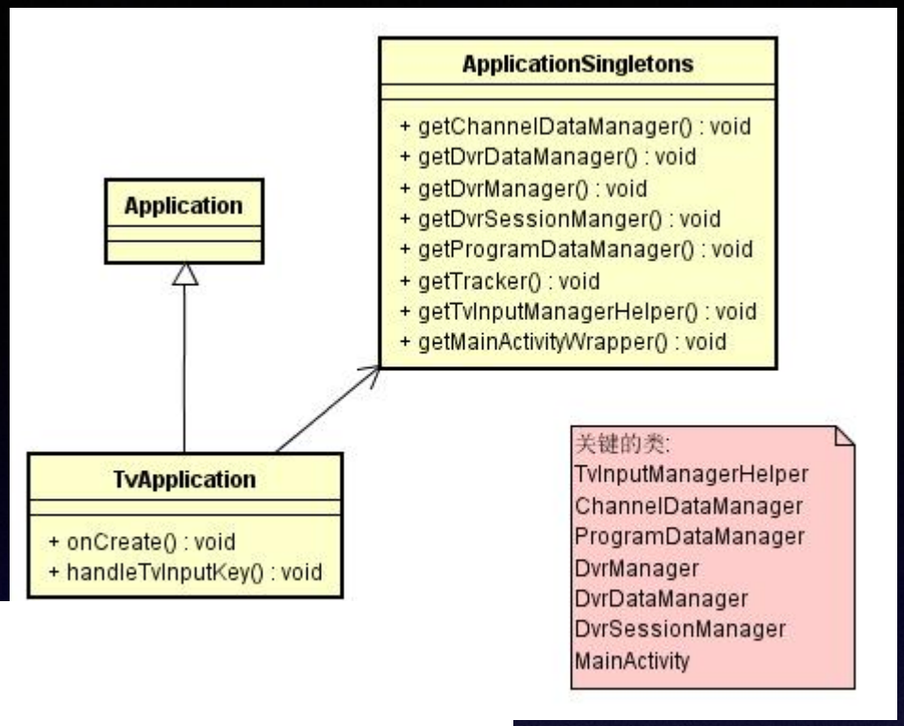
Android LiveTv

packages/apps/TV/

Support Features

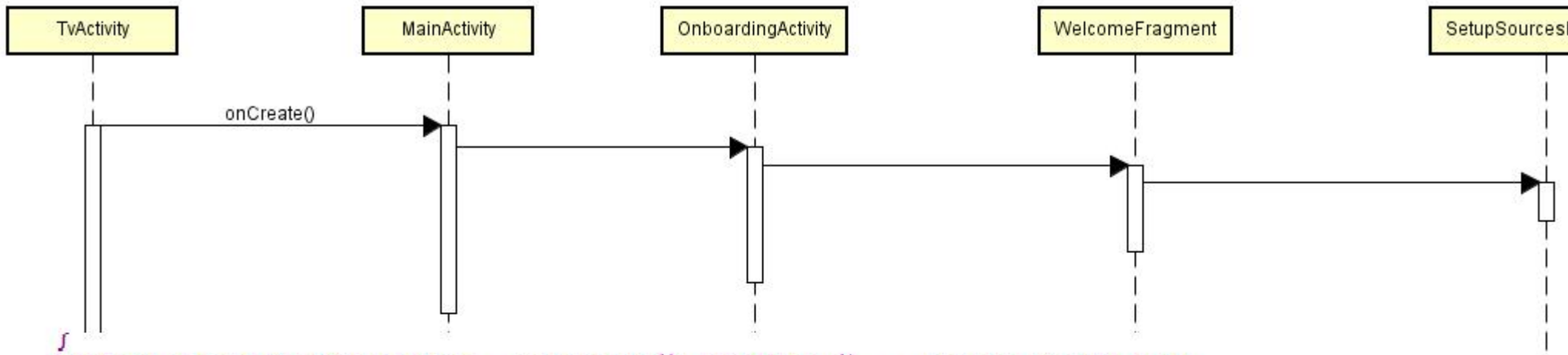
- Auto-detect TV Inputs
- Let TV Inputs initiate channel setup
- Control parental settings
- Access and navigate all TV channels
- Access TV program information bar
- Display Electronic Programming Guide (EPG) data
- Support multiple audio and subtitle tracks
- Supply parental control PIN challenge
- Allow TV Input UI overlay
- Populate search results for TV channels and programs
- Display app linking cards
- Support timeshifting
- Handle DVR functionality and support TV recording APIs

MainActivity



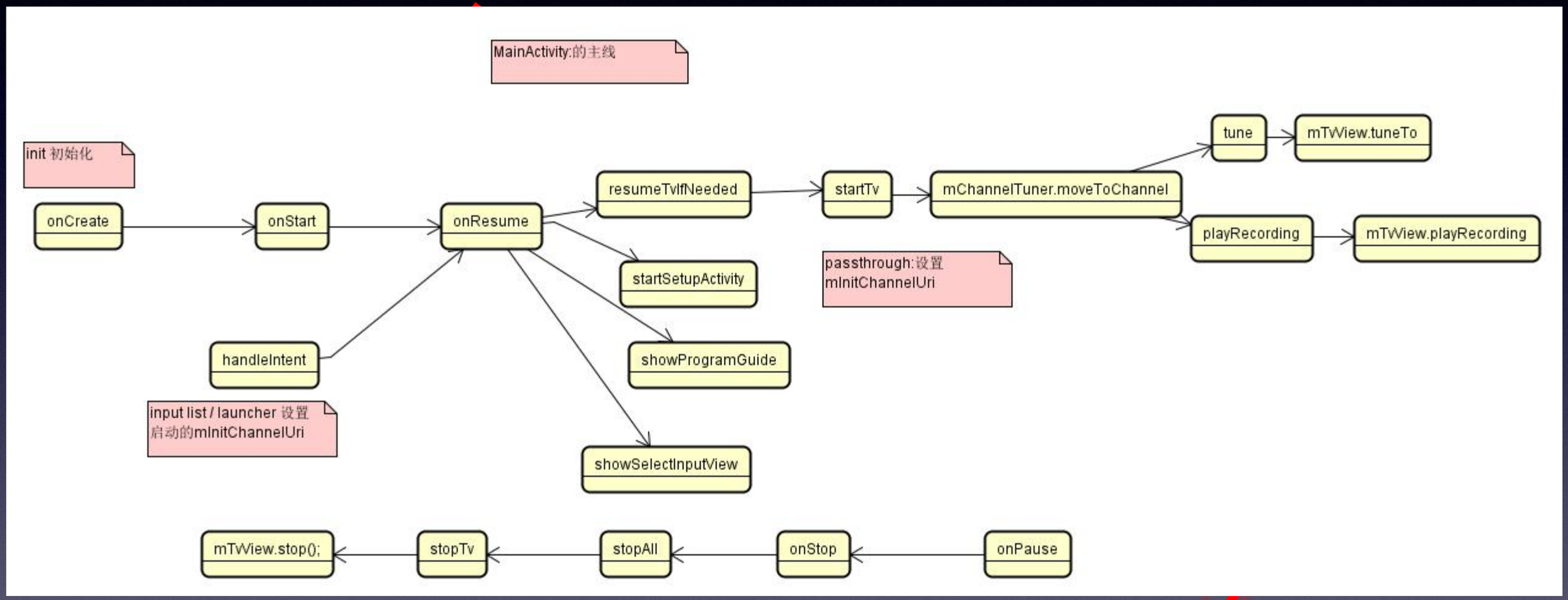
real

第一次启动时的flow

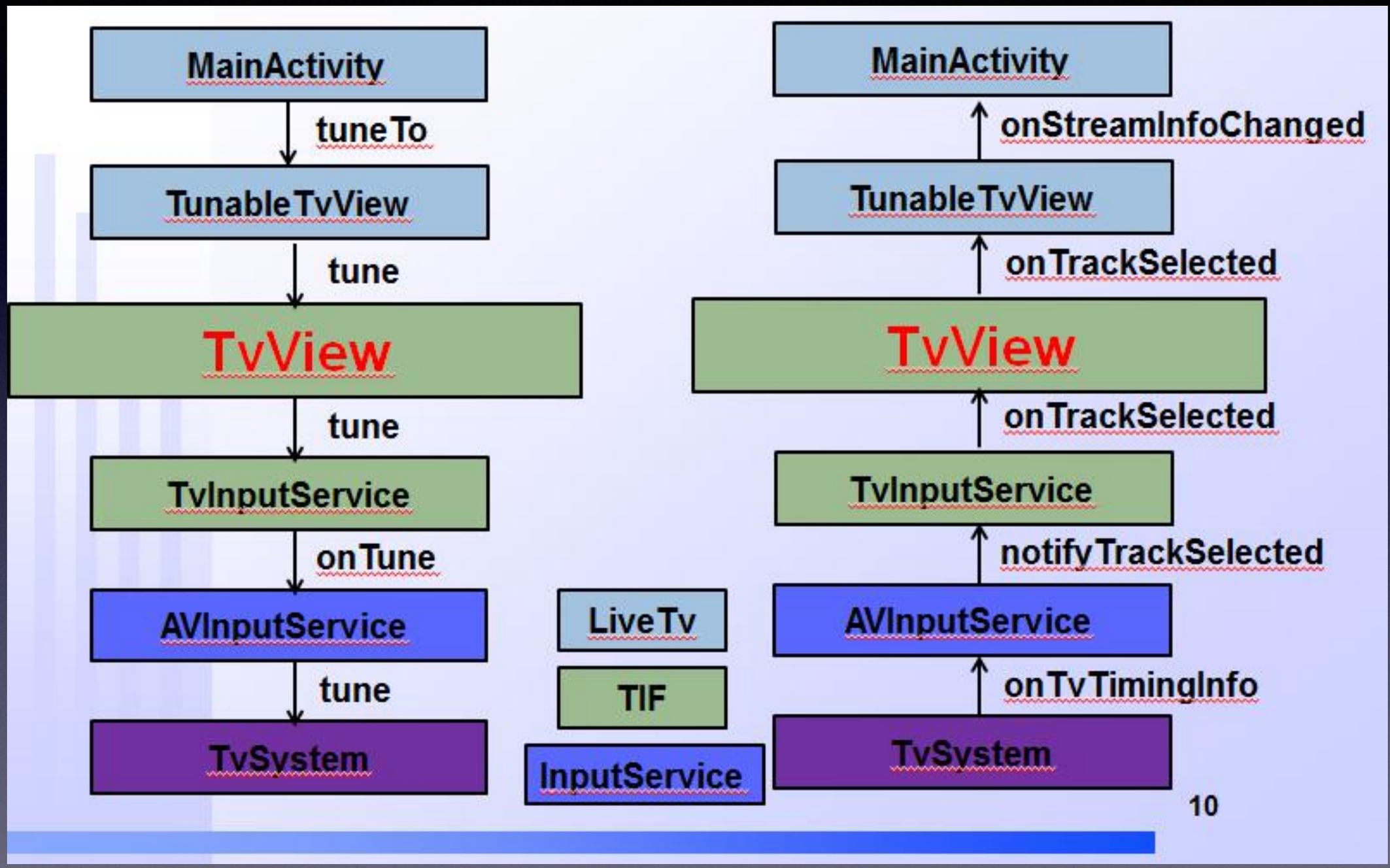



```
{
boolean skipToShowOnboarding = getIntent().getAction() == Intent.ACTION_VIEW
        && TvContract.isChannelUriForPassthroughInput(getIntent().getData());
if (Features.ONBOARDING_EXPERIENCE.isEnabled(this)
        && OnboardingUtils.needToShowOnboarding(this) && !skipToShowOnboarding
        && !TvCommonUtils.isRunningInTest()) {
    TODO: The onboarding is turned off in test, because tests are broken by the
    // onboarding. We need to enable the feature for tests later.
    startActivity(OnboardingActivity.buildIntent(this, getIntent()));
    finish();
    return;
}
```

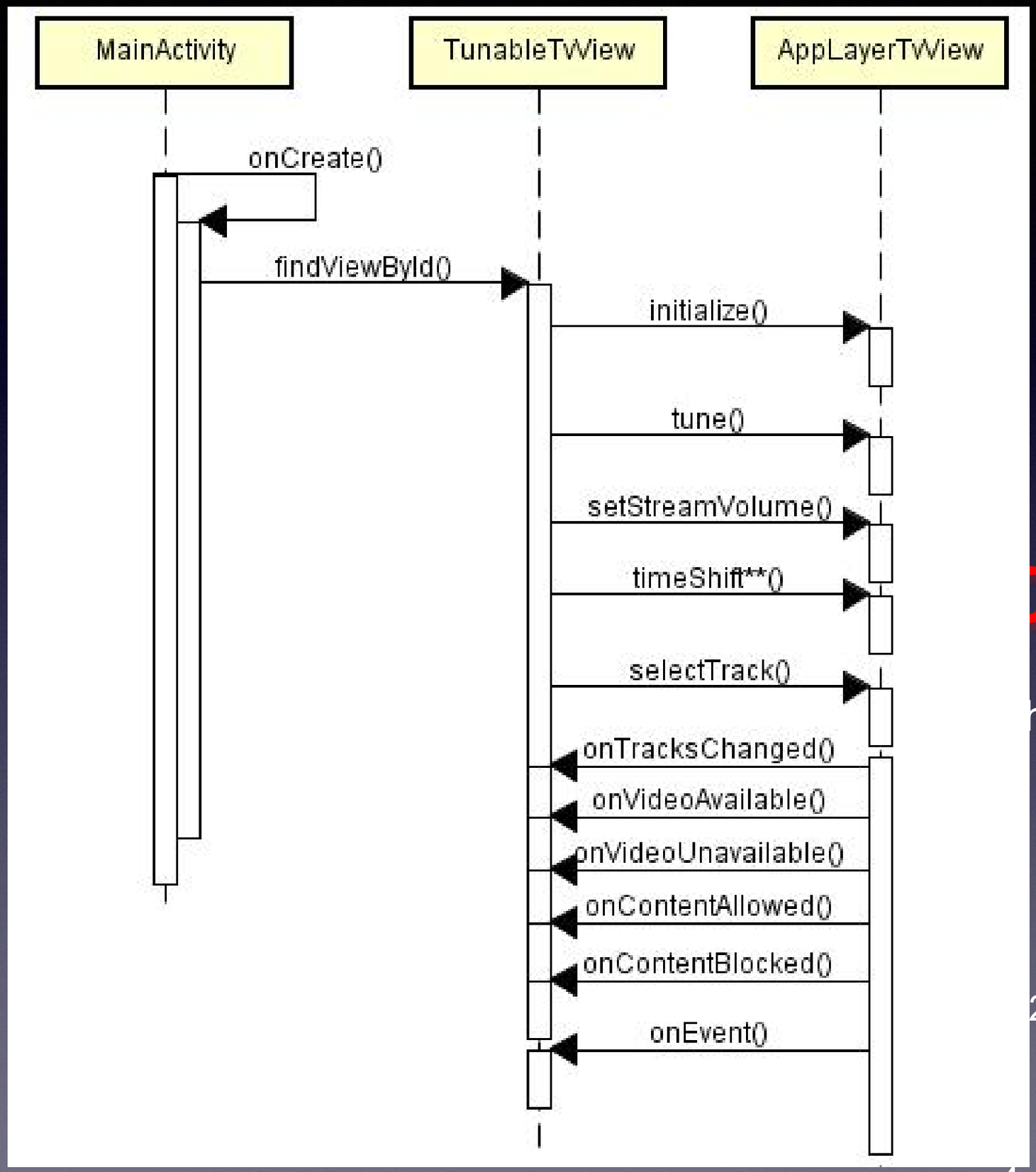
MainActivity



tune


MainActivity
tuneTo
TunableTvView
tune
TvView
tune
TvInputService
onTune
AVInputService
tune
TvSystem
LiveTv
TIF
InputService
MainActivity
onStreamInfoChanged
TunableTvView
onTrackSelected
TvView
onTrackSelected
TvInputService
notifyTrackSelected
AVInputService
onTvTimingInfo
TvSystem

tune




```
public class AppLayerTvView extends TvView {
```

TrackInfo:

```
private final int mType;
private final String mId;
private final String mLanguage;
private final CharSequence mDescription;
private final int mAudioChannelCount;
private final int mAudioSampleRate;
private final int mVideoWidth;
private final int mVideoHeight;
private final float mVideoFrameRate;
private final float mVideoPixelAspectRatio;
private final byte mVideoActiveFormatDescription;
```

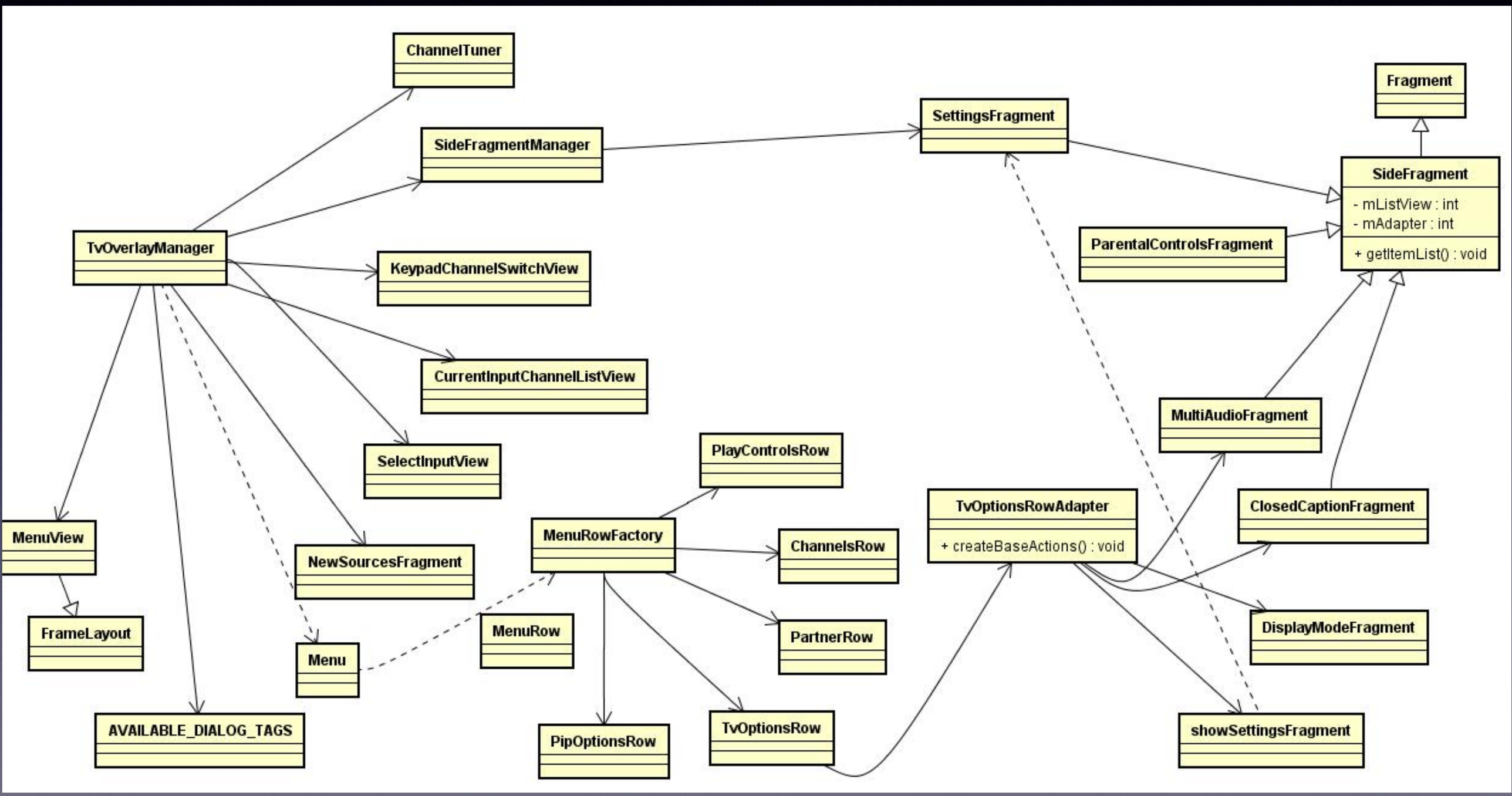

hideScreenByVideoAvailability(int reason)

VIDEO_UNAVAILABLE_REASON_UNKNOWN

VIDEO_UNAVAILABLE_REASON_TUNING = 1
VIDEO_UNAVAILABLE_REASON_WEAK_SIGN
2,
VIDEO_UNAVAILABLE_REASON_BUFFERING

VIDEO_UNAVAILABLE_REASON_AUDIO_ONL
= 4,
VIDEO_UNAVAILABLE_REASON_SCRAMBLE

Menu/Ui


ChannelTuner
SideFragmentManager
SettingsFragment
Fragment
SideFragment
- mListView : int
- mAdapter : int
+ getItemList() : void
TvOverlayManager
KeypadChannelSwitchView
ParentalControlsFragment
CurrentInputChannelListView
MultiAudioFragment
SelectInputView
PlayControlsRow
TvOptionsRowAdapter
+ createBaseActions() : void
ClosedCaptionFragment
MenuView
MenuRowFactory
ChannelsRow
NewSourcesFragment
DisplayModeFragment
FrameLayout
MenuRow
PartnerRow
Menu
AVAILABLE_DIALOG_TAGS
PipOptionsRow
TvOptionsRow
showSettingsFragment

- ChannelDataManager：

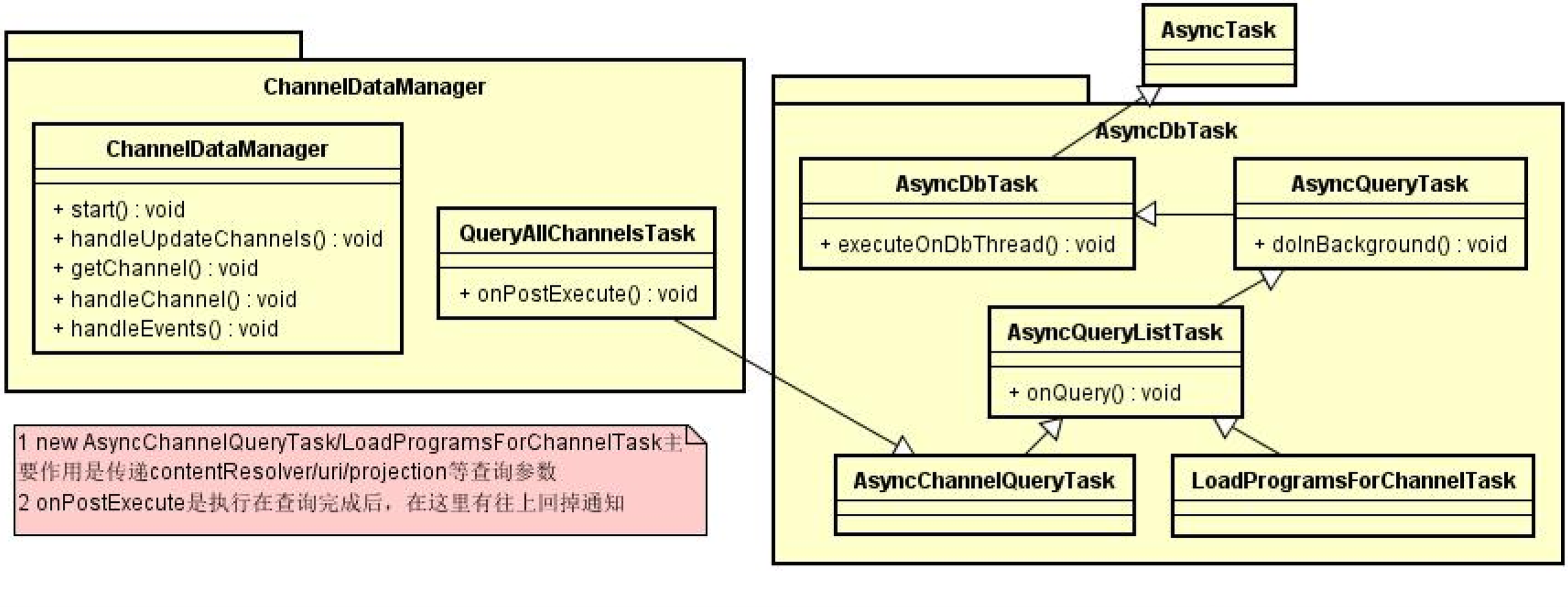
- manage channel data
  Query channel list from DB
  Update Channels#COLUMN_BROWSABLE
  Update Channels#COLUMN_LOCKED

ContentResolver：通过URI来操作table，query/insert/update/delete

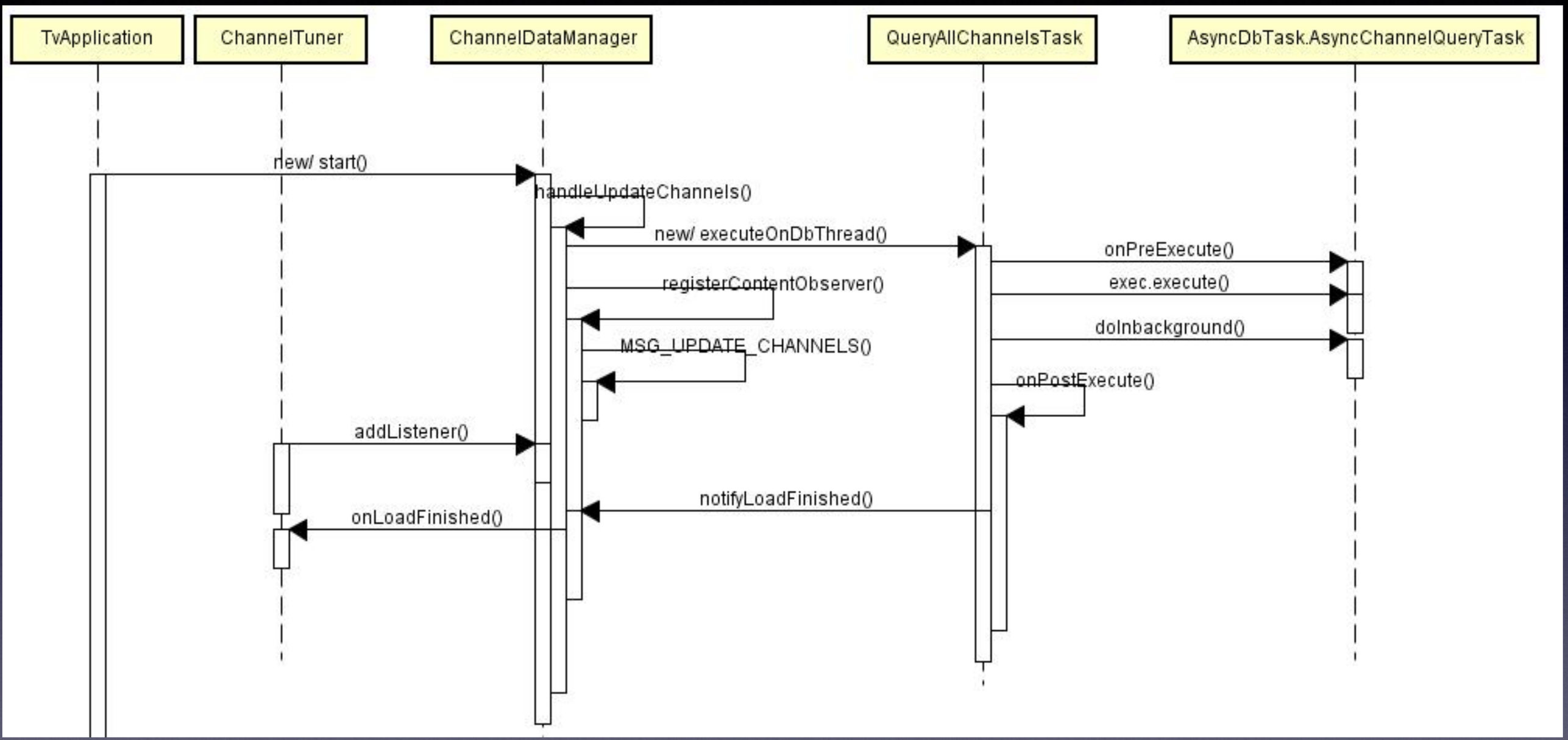
```
ContentResolver.insert(TvContract.Channels.CONTENT_URI, values);
TvContract.Channels.CONTENT_URI = content://android.media.tv/channel
ContentValues values = new ContentValues();
    values.put(TvContract.Channels.COLUMN_INPUT_ID, mInputId);
    values.put(TvContract.Channels.COLUMN_TYPE, mChannelType);
```

ContentObserver　//当table内容发生变化时，会调用它的onChange()方法

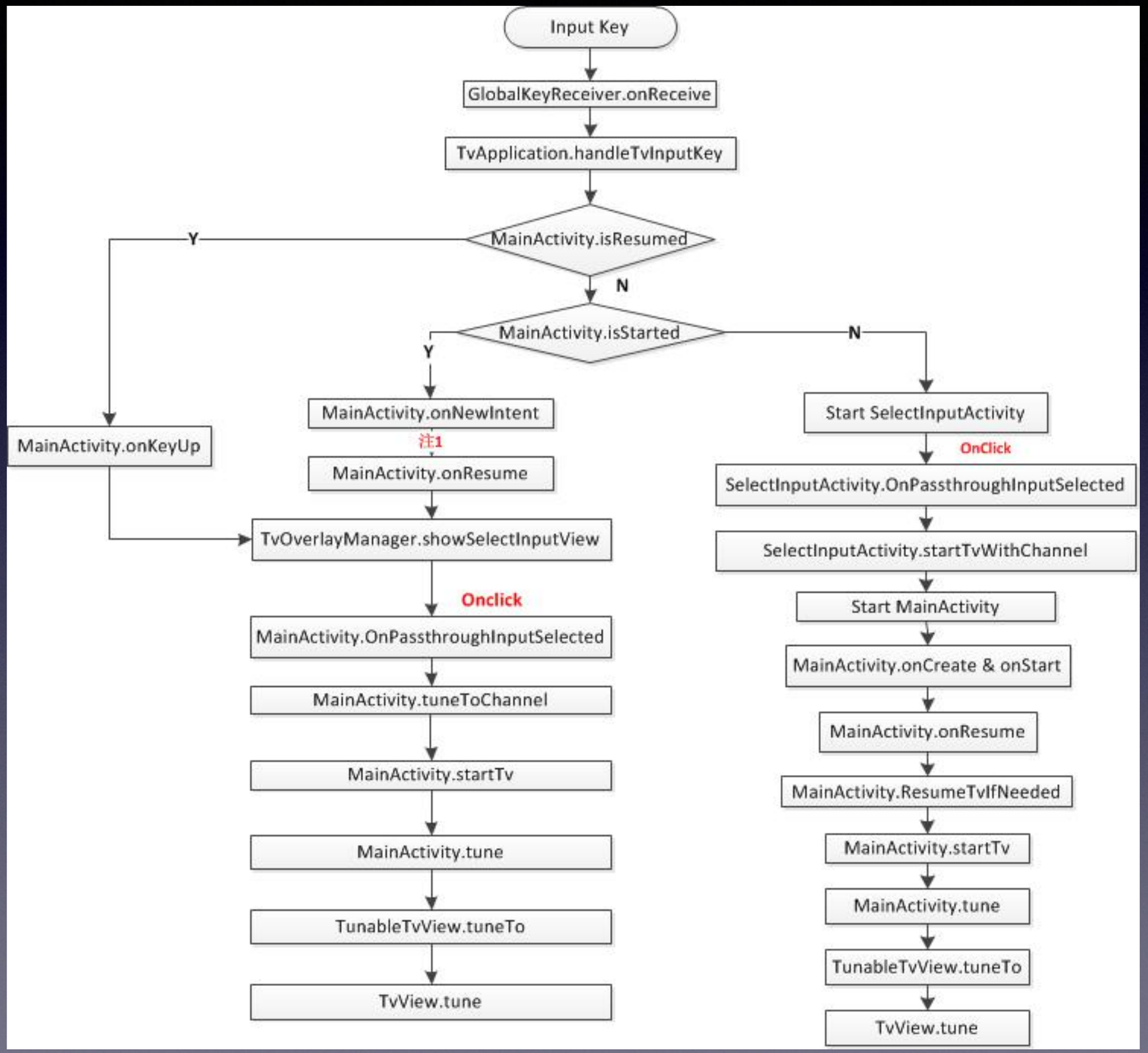
ChannelDataManager



ChannelDataManager



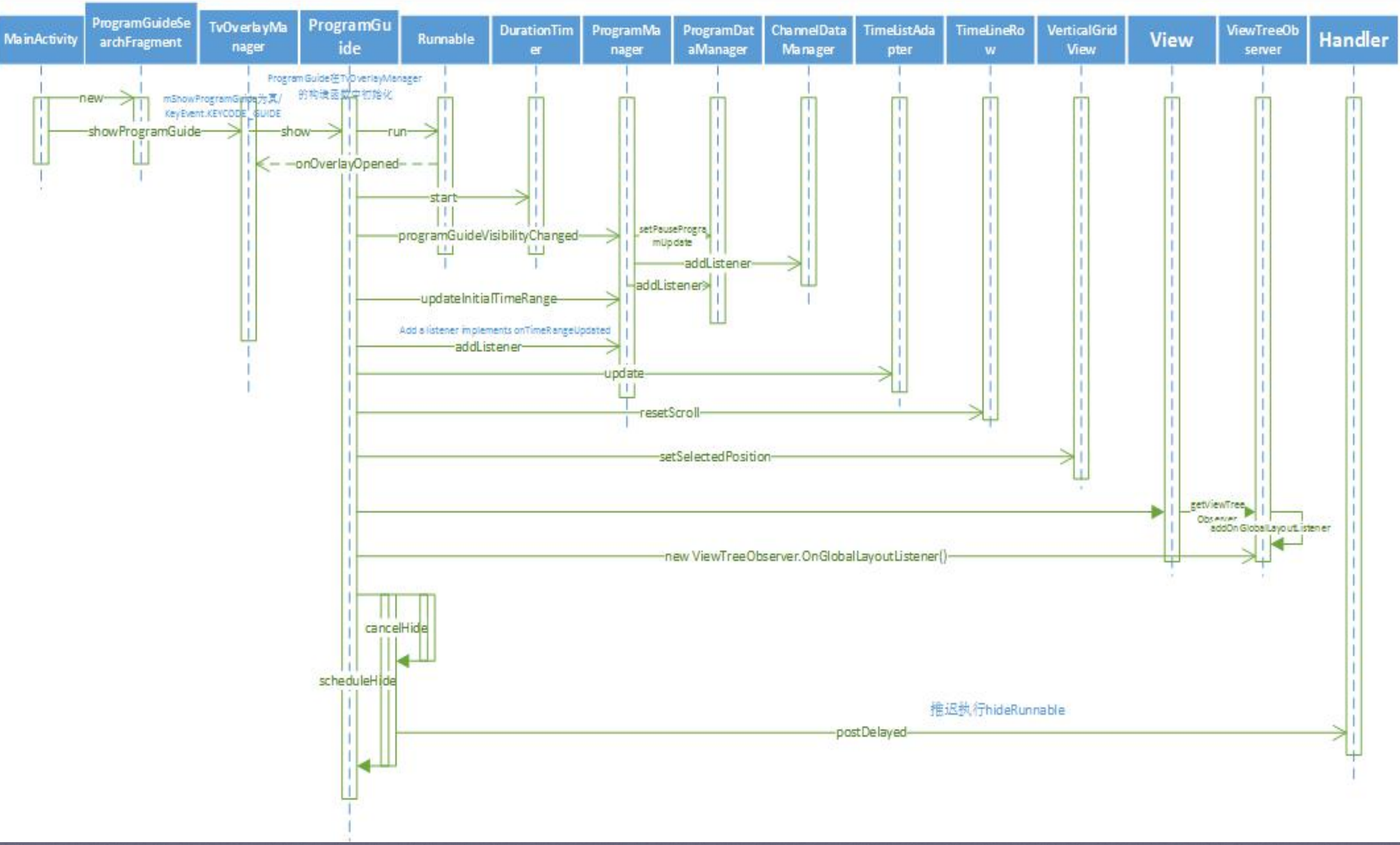
Input List


Input Key
GlobalKeyReceiver.onReceive
TvApplication.handleTvInputKey
MainActivity.isResumed
Y
N
MainActivity.isStarted
Y
N
MainActivity.onKeyUp
MainActivity.onNewIntent
注1
MainActivity.onResume
TvOverlayManager.showSelectInputView
Onclick
MainActivity.OnPassthroughInputSelected
MainActivity.tuneToChannel
MainActivity.startTv
MainActivity.tune
TunableTvView.tuneTo
TvView.tune
Start SelectInputActivity
OnClick
SelectInputActivity.OnPassthroughInputSelected
SelectInputActivity.startTvWithChannel
Start MainActivity
MainActivity.onCreate & onStart
MainActivity.onResume
MainActivity.ResumeTvIfNeeded
MainActivity.startTv
MainActivity.tune
TunableTvView.tuneTo
TvView.tune

Parental Control

主要的类
1.ProgramGuide：EPG的入口，提供了UI和操作。
2.ProgramGrid： 节目表UI。
3.ProgramManager：EPG中管理programs和channels。
4.ProgramRow：对应于一个program。
5.ProgramItemView：对应program中的一个视图。
6.TimelineRow：对应UI的时间栏，以切换program信息。
7.TableEntry： ProgramManager的内部类，对应program或programs之间的gap。


```
<meta-data android:name="android.media.tv.metadata.CONTENT_RATING_SYSTEMS"
        android:resource="@xml/tv_content_rating_systems" />
```


MainActivity
ProgramGuideSearchFragment
TvOverlayManager
ProgramGuide
Runnable
DurationTimer
ProgramManager
ProgramDataManager
ChannelDataManager
TimeListAdapter
TimeLineRow
VerticalGridView
View
ViewTreeObserver
Handler
new
showProgramGuide
show
run
onOverlayOpened
start
programGuideVisibilityChanged
setPauseProgramUpdate
addListener
addListener
updateInitialTimeRange
Add a listener implements onTimeRangeUpdated
addListener
update
resetScroll
setSelectedPosition
getViewTreeObserver
addOnGlobalLayoutListener
new ViewTreeObserver.OnGlobalLayoutListener()
cancelHide
scheduleHide
推迟执行hideRunnable
postDelayed

Parental Control

Parental Control允许用户阻止不需要的频道和节目，通过输入PIN码绕过该节目。该功能可以通过下面四种方式实现。

1.TV Provider

Channel类定义了PROJECTION_BASE的COLUMN_LOCKED字段，无需输入PIN码即可锁住指定频道。

•TV Input Manager

TvInputManager存储了所有blocked的TvContentRating，可以通过isRatingBlocked函数来判断一个Tv content是否是blocked。

•TV Input

当显示内容的rating发生变化（Program或Channel更改导致）或Parental Control设置已更改(ACTION_BLOCKED_RATINGS_CHANGED和ACTION_PARENTAL_CONTROLS_ENABLED_CHANGED), Tv Input通过调用TvInputManager的isRatingBlocked()来检查当前内容是否应blocked。 如果内容应该blocked，Tv Input禁用音频和视频，并通过调用notifyContentBlocked（TvContentRating）通知Tv App当前内容blocked。 如果内容不应被阻止，则TV Input启用音频和视频，并通过调用notifyContentAllowed（）通知Tv App允许当前内容。

•Tv Apk

Tv Apk提供了管理Parental Control的管理方式。通过TvInputManager来存储TvContentRating，通过Tv Provider来存储blocked 的Channel。两个重要的类ContentRatingsManager和RatingSystemsFragment。

```
<meta-data android:name="android.media.tv.metadata.CONTENT_RATING_SYSTEMS"
        android:resource="@xml/tv_content_rating_systems" />
```

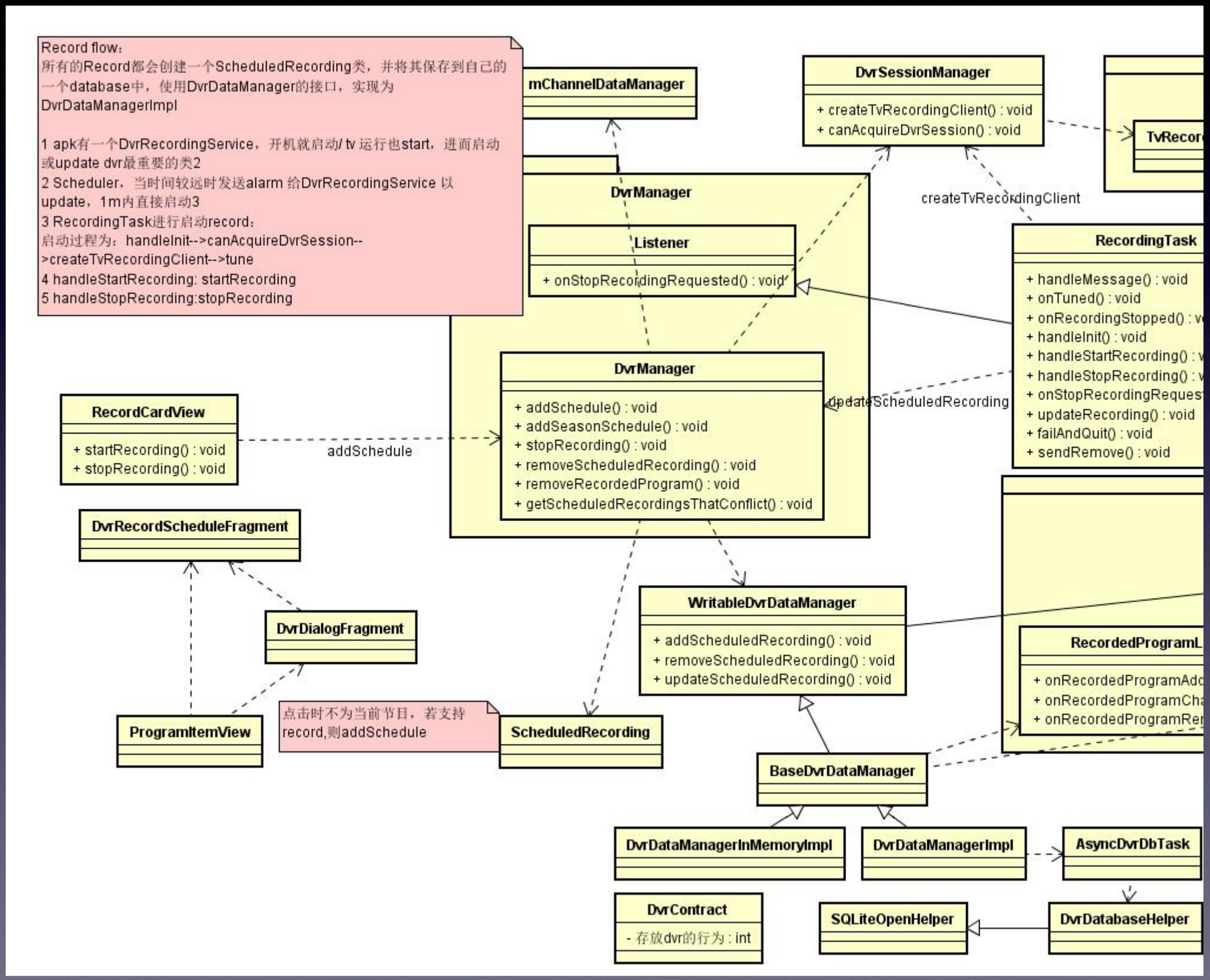
```
public final class TvContentRating {
    TODO: Consider to use other DELIMITER
    // in the main ratings.
    private static final String DELIMITER = "/";

    private final String mDomain;
    private final String mRatingSystem;
    private final String mRating;
    private final String[] mSubRatings;
    private final int mHashCode;
```

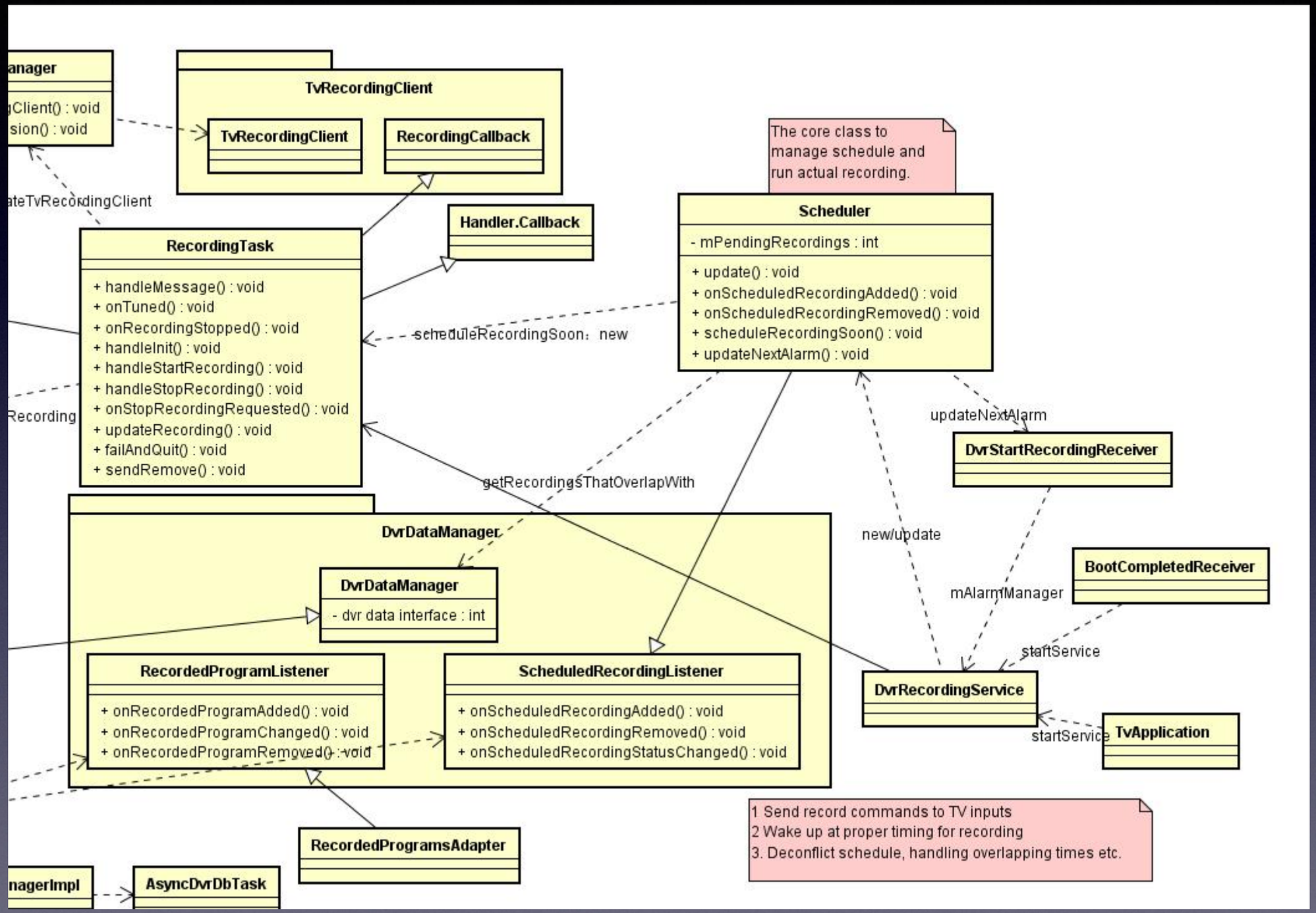
```
     *      <tr>
     *          <td>DVB_6</td>
     *          <td>Recommended for ages 6 and over</td>
     *      </tr>
```

```
/**
 * Constructs a TvContentRating object from a given rating and sub-rating constants.
 *
 * @param domain The string for domain of the content rating system such as "com.android.tv".
 * @param ratingSystem The rating system string such as "US_TV".
 * @param rating The content rating string such as "US_TV_PG".
 * @param subRatings The sub-rating strings such as "US_TV_D" and "US_TV_L".
 */
private TvContentRating(
        String domain, String ratingSystem, String rating, String[] subRatings) {
    mDomain = domain;
    mRatingSystem = ratingSystem;
    mRating = rating;
    if (subRatings == null || subRatings.length == 0) {
        mSubRatings = null;
    } else {
        Arrays.sort(subRatings);
        mSubRatings = subRatings;
    }
    mHashCode = 31 * Objects.hash(mDomain, mRating) + Arrays.hashCode(mSubRatings);
}
```

DVR


Record flow:
所有的Record都会创建一个ScheduledRecording类，并将其保存到自己的一个database中，使用DvrDataManager的接口，实现为DvrDataManagerImpl
1 apk有一个DvrRecordingService，开机就启动/ tv 运行也start，进而启动或update dvr最重要的类2
2 Scheduler，当时间较远时发送alarm 给DvrRecordingService 以update，1m内直接启动3
3 RecordingTask进行启动record：
启动过程为：handleInit-->canAcquireDvrSession-->createTvRecordingClient-->tune
4 handleStartRecording: startRecording
5 handleStopRecording:stopRecording
mChannelDataManager
DvrSessionManager
+ createTvRecordingClient() : void
+ canAcquireDvrSession() : void
createTvRecordingClient
DvrManager
Listener
+ onStopRecordingRequested() : void
RecordingTask
+ handleMessage() : void
+ onTuned() : void
+ handleInit() : void
+ updateRecording() : void
+ failAndQuit() : void
+ sendRemove() : void
DvrManager
+ addSchedule() : void
+ addSeasonSchedule() : void
+ stopRecording() : void
+ removeScheduledRecording() : void
+ removeRecordedProgram() : void
+ getScheduledRecordingsThatConflict() : void
updateScheduledRecording
RecordCardView
+ startRecording() : void
+ stopRecording() : void
addSchedule
DvrRecordScheduleFragment
DvrDialogFragment
ProgramItemView
点击时不为当前节目，若支持record,则addSchedule
ScheduledRecording
WritableDvrDataManager
+ addScheduledRecording() : void
+ removeScheduledRecording() : void
+ updateScheduledRecording() : void
BaseDvrDataManager
DvrDataManagerInMemoryImpl
DvrDataManagerImpl
AsyncDvrDbTask
DvrContract
- 存放dvr的行为 : int
SQLiteOpenHelper
DvrDatabaseHelper

DVR


anager
gClient() : void
sion() : void
TvRecordingClient
TvRecordingClient
RecordingCallback
ateTvRecordingClient
Handler.Callback
RecordingTask
+ handleMessage() : void
+ onTuned() : void
+ onRecordingStopped() : void
+ handleInit() : void
+ handleStartRecording() : void
+ handleStopRecording() : void
+ onStopRecordingRequested() : void
+ updateRecording() : void
+ failAndQuit() : void
+ sendRemove() : void
Recording
The core class to manage schedule and run actual recording.
Scheduler
- mPendingRecordings : int
+ update() : void
+ onScheduledRecordingAdded() : void
+ onScheduledRecordingRemoved() : void
+ scheduleRecordingSoon() : void
+ updateNextAlarm() : void
scheduleRecordingSoon：new
updateNextAlarm
DvrStartRecordingReceiver
getRecordingsThatOverlapWith
DvrDataManager
new/update
BootCompletedReceiver
DvrDataManager
- dvr data interface : int
mAlarmManager
startService
RecordedProgramListener
+ onRecordedProgramAdded() : void
+ onRecordedProgramChanged() : void
+ onRecordedProgramRemoved() : void
ScheduledRecordingListener
+ onScheduledRecordingAdded() : void
+ onScheduledRecordingRemoved() : void
+ onScheduledRecordingStatusChanged() : void
DvrRecordingService
startService
TvApplication
1 Send record commands to TV inputs
2 Wake up at proper timing for recording
3. Deconflict schedule, handling overlapping times etc.
RecordedProgramsAdapter
nagerImpl
AsyncDvrDbTask

DVR

APP层

内部接口

RecordingCallback接口是在LiveTV的RecordingTask里被实现，主要是在回调中startrecording和更新数据库等操作。

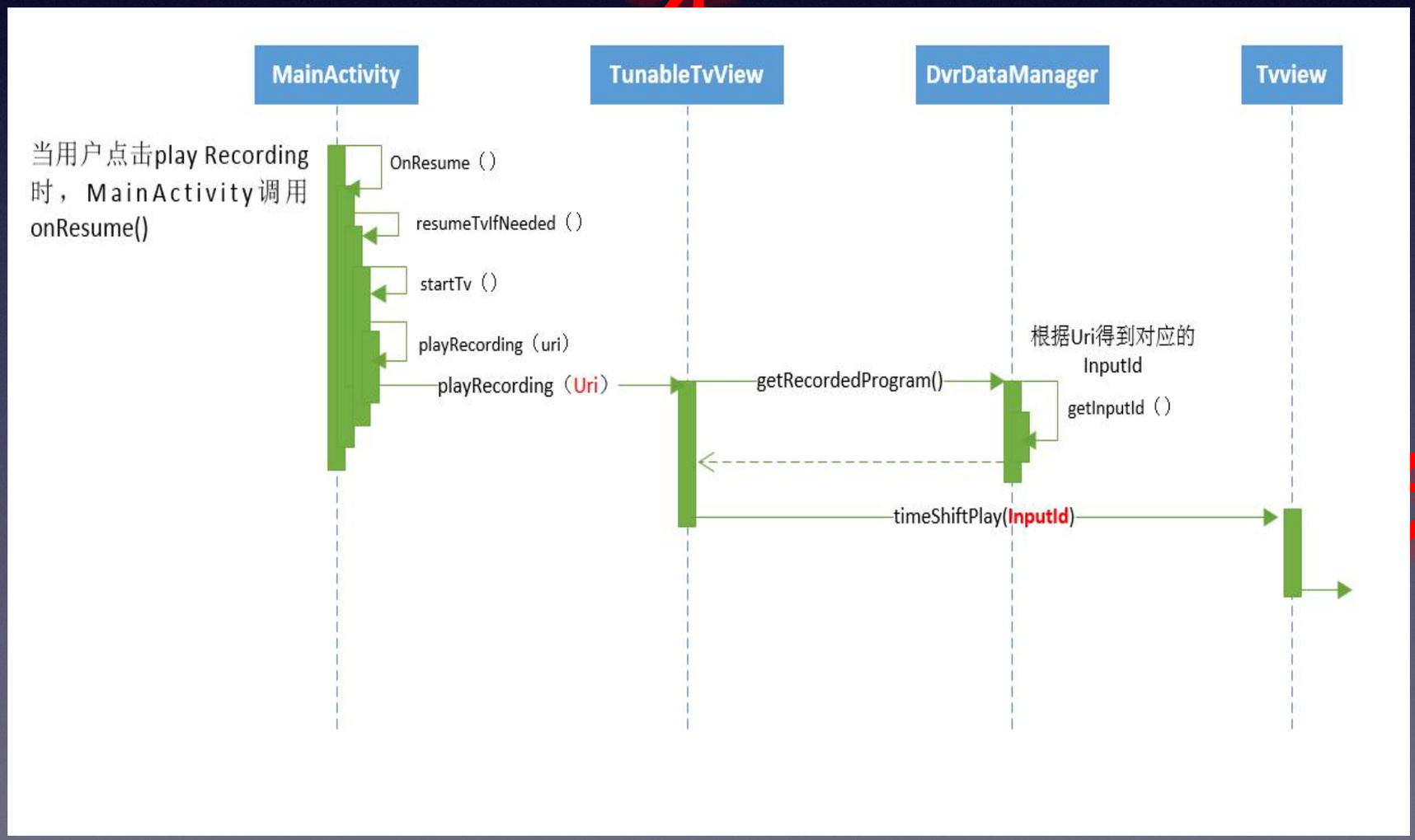
TIF层StartRecording过程：

stopRecording过程

Timeshift

TvView
-mTvInputManager
+ timeShiftPause() + timeShiftPlay() + timeShiftResume() + timeShiftSeekTo() + timeShiftSetPlaybackParams()

realtek



- The TV Input Service tells the TV App how many tuners are available so that the TV App can handle possible resource conflict.
- The TV App receives a user-initiated request to record a TV program.
- The TV App stores the recording schedule in its internal database.
- When it’s time to record, the TV App passes a request to tune to the channel associated with the recording.
- The TV Input Service receives this request, responds with whether or not there are appropriate resources, and tunes to the channel.
- Then the TV App passes a request to start recording to the TV Input Manger.
- The TV Input Service receives this request and starts recording.
- The TV Input Service stores the actual video data in its storage, which can be external storage or cloud storage.
- When it's time to finish the recording, the TV App passes the stop recording request to the TV Input Manager.
- Once the TV Input Service receives the request, it stops the recording and adds its associated metadata to the TV Provider so that the TV App can show the recording to users when requested.

Realtek DTV Input

device/realtek/app/DTVInput

```
drwxrwxr-x 2 bruce_zhang bruce_zhang  4096 7月   14 16:52 closedcaption
drwxrwxr-x 2 bruce_zhang bruce_zhang  4096 7月   14 16:52 data
drwxrwxr-x 6 bruce_zhang bruce_zhang  4096 7月   13 15:33 DigitalSetup
-rw-rw-r-- 1 bruce_zhang bruce_zhang  1327 6月    9 16:45 IsoUtils.java
drwxrwxr-x 2 bruce_zhang bruce_zhang  4096 7月   13 14:56 setup
drwxrwxr-x 2 bruce_zhang bruce_zhang  4096 7月   14 16:52 tvinput
-rwxrwxr-x 1 bruce_zhang bruce_zhang 42614 7月   14 16:52 TvServiceHelper.java
drwxrwxr-x 2 bruce_zhang bruce_zhang  4096 7月   14 16:52 util
drwxrwxr-x 2 bruce_zhang bruce_zhang  4096 7月   10 16:25 view
```



```
bruce_zhang@server-20:~/workspace/android/nougat/kernel/android/nougat/device/realtek/app/DTVInput/src/com/realtek/dtv/DigitalSetup$ ls
atsc                                DigitalSelectRegionFragment.java          SatelliteScanChannelFragment.java
AudioMixingLevelActivity.java       DigitalSetupUtils.java                    SatelliteSelectedConfigSetFragment.java
AudioMixingLevelFragment.java       DigitalTuningFragment.java                SatelliteSelectedSettingFragment.java
AudioSetupFragment.java             dvb                                       SatelliteSetupFragment.java
DigitalAutoTuningFragment.java      GuideSetupFragment.java                   SatelliteTuningFragment.java
DigitalChannelSetupActivity.java    isdb                                      SatelliteTuningStartFragment.java
DigitalChannelSetupFragment.java    ProgrameListEditFragment.java             ScanChannelFragment.java
DigitalManualTuningFragment.java    SatallitAutoServiceUpdateFragment.java    SubtitleSetupFragment.java
DigitalManualTuningResultFragment.java  SatallitTunerModeSelectionFragment.java  TechnicalSetupFragment.java
DigitalOperatorFragment.java        satellite                                 UpdateDisplayUtils.java
DigitalOperatorTuningFragment.java  SatelliteListFragment.java
```