Android Storage

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Customization Guide

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Document Revision History

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1 Overview

1.1 Summary

- NEW architecture (it is totally different with L).
  - It includes new command/flow between vold and AF
- it is based on new concept about “disk” that it can mount all partitions in the disk .
  - However, it only can mount one partition in the disk in L
- NEW feature: Adoptable Storage
  - Adopting an external storage device encrypts and formats the device to behave like internal storage
  - Because this feature, the number of storage list for apps is not fixed
    - If we format the external sd as internal, but not migrate data to it. Then the apps can NOT see the storage. For apps, the number of the storage list is decreased
  - The primary storage can be changed by “migrate data”

1.2 Mount path

- Mount path is not fixed.
- You can use fixed path for primary storage because it has symbolic link on it
  - Ex: you can access the primary storage by /sdcard, /mnt/sdcard
- However, it doesn’t have fixed path for secondary storages

	Mount path format	**Example**	
		Primary storage	Secondary storage
L	/storage/[label]	/storage/sdcard0	/storage/sdcard1
M	emulated internal sdcard(/data/media): ==> /storage/emulated portable storage: ==> /storage/[UUID]	/storage/emulated	/storage/3C2A-1EEE

```
export ANDROID_STORAGE /storage
# Support legacy paths
symlink /sdcard /mnt/sdcard
symlink /sdcard /storage/sdcard0
```

```
root@4560MMX_sprout:/ # df
df
Filesystem               Size     Used     Free   Blksize
/dev                   479.6M    56.0K   479.6M   4096
/sys/fs/cgroup         479.6M    12.0K   479.6M   4096
/mnt                   479.6M     0.0K   479.6M   4096
/system                787.4M   409.3M   378.1M   4096
/data                    2.0G   165.6M     1.8G   4096
/cache                 122.0M    64.0K   121.9M   4096
/protect_f               5.8M    56.0K     5.8M   4096
/protect_s               5.8M    52.0K     5.8M   4096
/oem                    59.0M    44.0K    58.9M   4096
/storage               479.6M     0.0K   479.6M   4096
/mnt/runtime_default/emulated     2.0G   165.6M     1.8G   4096
/storage/emulated        2.0G   165.6M     1.8G   4096
/mnt/runtime_read/emulated     2.0G   165.6M     1.8G   4096
/mnt/runtime_write/emulated     2.0G   165.6M     1.8G   4096
/mnt/media_rw/D80D-08DB   255.9M   320.0K   255.6M   32768
/mnt/media_rw/3C2A-1EEE     1.9G    64.0K     1.9G   32768
/mnt/runtime_default/3C2A-1EEE     1.9G    64.0K     1.9G   32768
/storage/3C2A-1EEE       1.9G    64.0K     1.9G   32768
/mnt/runtime_read/3C2A-1EEE     1.9G    64.0K     1.9G   32768
/mnt/runtime_write/3C2A-1EEE     1.9G    64.0K     1.9G   32768
root@4560MMX_sprout:/ #
```

1.3 Mount path (MTK modified)

- The modification is only in Turkey and BSP package. No in basic package
- To make the end user to know the storage path more easily, mtk create the symbolic link to the storages
- It also can get the path by property
- The symbolic link or property is only valid when the storage is mounted

	Storage Type	Mount Point	Symbolic link	Property
Mtk Modified	Internal stoarge	/storage/emulated/0	/mnt/m_internal_storage	vold.path.internal_storage
	External SD	/storage/[UUID]	/mnt/m_external_sd	vold.path.external_sd
	Phone Storage	/storage/[UUID]	/mnt/m_phone_storage	vold.path.phone_storage

```
root@k35v1_64:/ # ls -l /mnt/
ls -l /mnt/
drwxr-xr-x root     system            2015-01-01 19:30 asec
d---------- system   system            2015-01-01 19:30 cd-rom
drwxrwx--x system   system            2015-01-01 19:52 expand
lrwxrwxrwx root     root              2015-01-01 19:52 m_external_sd -> /storage/C0D6-1B13
lrwxrwxrwx root     root              2015-01-01 19:52 m_internal_storage -> /storage/emulated/0
drwxr-x--- root     media_rw          2015-01-01 19:52 media_rw
drwxr-xr-x root     system            2015-01-01 19:30 obb
drwx------ root     root              2015-01-01 19:30 runtime
```

2 The Change between L and M

Item	L	M	Need to do in M
The number of partition that can be mounted in one disk	Only one partition can be mounted	All partitions can be mounted	
Mount path	/storage/[label]	/storage/[UUID]	Don't hardcode the path (Ex: /storage/sdcard1) Please use StorageManager.getVolumeList() or Environment. getExternalStorageDirectory()
The number of storage	Fixed	Changed after the user adopts the storage	Don't expect some storage will exist all the time(Ex: the external sd will disappear after adopted) Please use StorageManager.getVolumeList() to enumerate the storages
Primary Storage	The primary storage is always /storage/sdcard0	After the user 'migrate data' to the storage, then it becomes primary	In M, for backward compatibility, you can access the primary storage by symbolic link, /sdcard or /mnt/sdcard
Secondary Storage	The secondary storage is always /storage/sdcard1	The path is /storage/[UUID]	You can not access the secondary storage by 'fixed path' [MTK modification] create the symbolic link (/mnt/m_xxx) for storages

☞ [Random filler text. Not intended for actual reading.] Must keep the chapter even it have empty content.

Item	L	M	Need to do in M
Command/flow between vold and AF	Version 2.1	Version 3.0 Many command/flow are different from L	If you use or parse the following command, you need to fix it • vdc command • Ex: 'vdc volume list' is removed in M • dumpsys mount
MTK_SHARED_SDCARD	Support	It still has the feature. However it only means different partition layout('intsd' partitiion exist or not)	
MTK_2SDCARD_SWAP	Support	Removed completely. It is replaced by 'Adoptable Storage' feature	Remove the related source code about MTK_2SDCARD_SWAP

3 Adoptable Storage

3.1 Reference

– http://developer.android.com/preview/behavior-changes.html#behavior-adoptable-storage

3.2 Adoptable Storage Devices

– Adopting an external storage device encrypts and formats the device to behave like internal storage

– After adopted, the storage would be formatted(the data will be lost) and becomes encrypted and the file system is changed from FAT to Ext4

3.3 How to enable

– You can enable ‘adoptable storage’ for specific storage in fstab.xxx

  ▪ Set “encryptable=userdata“ flag

  ▪ Ex:

– For debug, you can enable ‘adoptable storage’ for all vold managed storages

  ▪ adb shell sm set-force-adoptable true

  ▪ It will set ‘forceAdoptable’ flag to true in /data/system/storage.xml

3.4 Storage path is dynamically changed and it always needs to call the storage related APIs dynamically

– If your app accesses the following APIs or fields, be aware that the file paths they return will dynamically change when the app is moved between internal and external storage devices. When building file paths, it is strongly recommended that you always call these APIs dynamically. Don’t use hardcoded file paths or persist fully-qualified file paths that were built previously.

☞ [Random filler text. Not intended for actual reading.] Must keep the chapter even it have empty content.

4 Storage Definition

4.1 Internal Storage (two meanings)

– /data. It is not a storage that you can NOT save pictures in it

– or /data/media that is used as 'storage'. You can save some pictures in it

4.2 Portable storage

– The storage is NOT encrypted and its filesystem is FAT. It can be used in another device or PC

4.3 Emulated storage

– The storage is emulated to another storage type

  ▪ Ex: the external sdcard is emulated as internal storage. Or /data/media is emulated as a storage

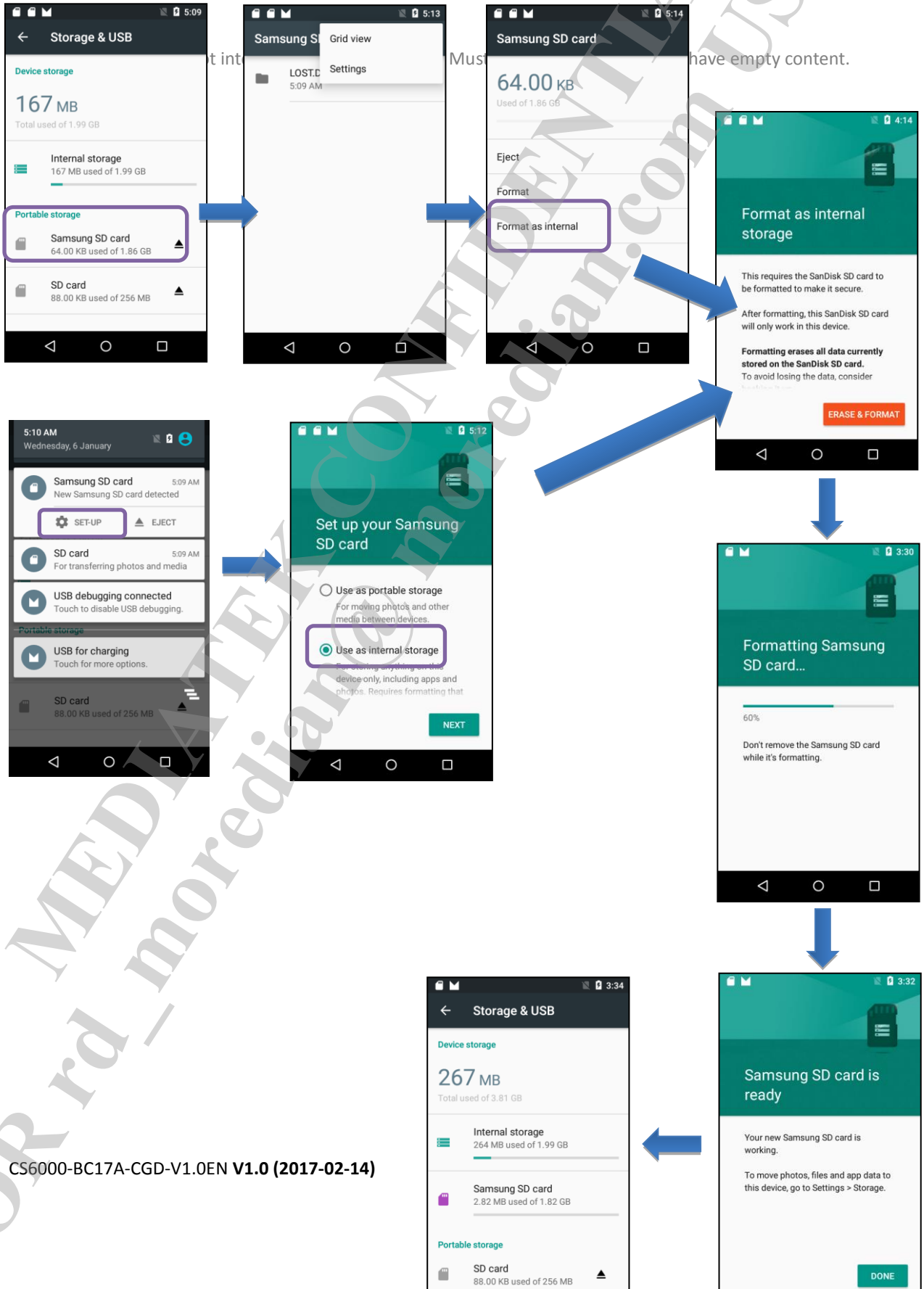
4.4 Adopted storage

– It was a portable storage. And now, it is formatted as internal that is encrypted and its filesystem is changed to Ext4

4.5 You can format a portable storage as internal storage by

– Settings->Storage &USB

– Notification bar



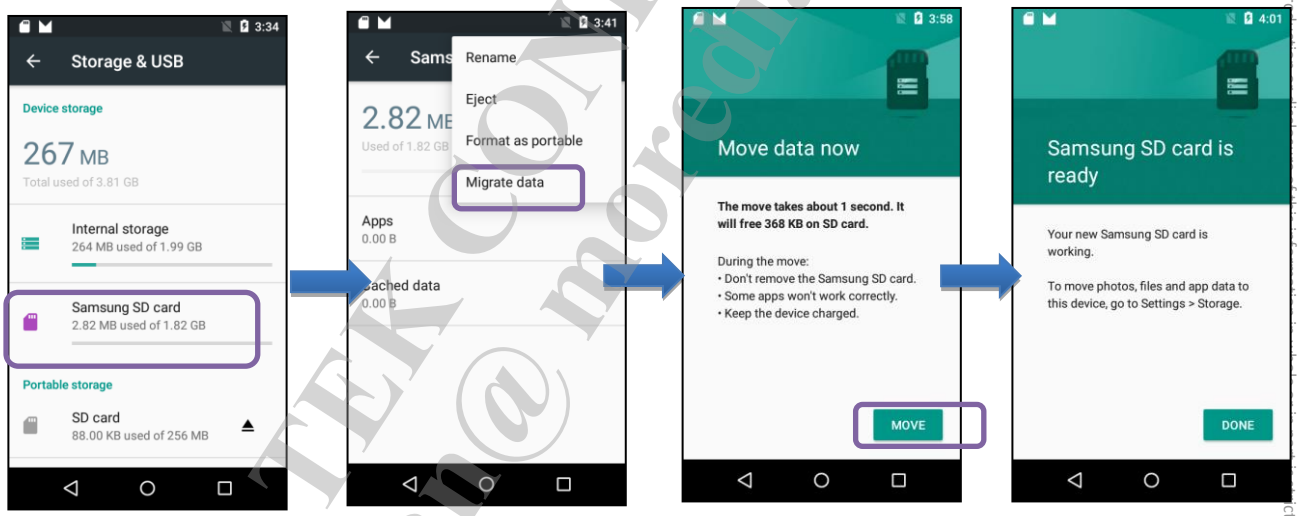
4.6 After the storage format as internal, then it can be set to primary by migrate data

– Migrate data

  - It will move all data of the current primary storage to the selected storage. And after that, set the selected storage to primary

– Only ONE emulated storages can be used at the same time

  - If you “migrate data” in internal storage(/data/media), the end user can NOT save the data to “Samsung SD card”
  - If you “migrate data” in “Samsung SD card”, the end user can NOT save the data to internal storage(/data/media),



5 The Number of Volume list for APPs are NOT fixed

- For App, the result of getVolumeList() in StorageManager is not fixed
  - The storage number can be changed according the user scenario

		Case1	Case1 -> Case2	Case2 -> Case3	Case3 -> Case4
Description			Migrate data for internal storage (/data)	Format external sd to internal and migrate data to it	migrate data to the internal storage(/data)
Emulated storages	All emulated storages		Internal storage (/data/media)	2 emuluated storages: Internal storage (/data/media) and adopted external storage	2 emuluated storages: Internal storage (/data/media) and adopted external storage
	Visible by Apps		Internal storage (/data/media)	Adopted external storage	Internal storage
Portable Storages		External SD	External SD	None	None
Total number storage in Volume List for Apps		**1** (1 portable storage)	**2** (1 emulated storage, 1 portable storage)	**1** (1 emulated storage)	**1** (1 emulated storage)

- Some APPs(ex: Mtklogger) need to modify
- Sample code

You can decide to handle the storage or not by StorageVolume or VolumeInfo

```
final Context context = getActivity();
mStorageManager = context.getSystemService(StorageManager.class);
StorageVolume[] sv = mStorageManager.getVolumeList();
for (int i = 0; i < sv .length; i++) {
    String path = sv[i].getPath();
    String state = mStorageManager.getVolumeState(path);
    Log.i(TAG, "description='" + sv[i].getDescription(context)+ "', path='" + path +"',
status="+state);
    VolumeInfo vi = mStorageManager.findVolumeById(sv[i].getId());
    if (vi.getDisk() != null) {
        Log.i(TAG, "Disk().flags: '" + vi.getDisk().flags+"'");
        Log.i(TAG, "Disk().isSd(): '" + vi.getDisk().isSd() +"'");
        Log.i(TAG, "Disk().isUsb(): '" + vi.getDisk().isUsb() +"'");
    }
```

6 How to Get Storage Status

- For debugging, you can use “adb shell dumpsys mount” to know the storage status
- For example, we has 2 emulated storages
  - Internal storage(/data/media)
  - The external sdcard that is already formatted as internal
- Choose the internal storage(/data/media) to primary by “migrate data”
  - Its mountFlag is PRIMARY, and mount path is /storage/emulated

```
root@4560MMX_sprout:/ # dumpsys mount
dumpsys mount
Disks:
  DiskInfo{disk:179,128}:
    flags=ADOPTABLE|SD size=2002780160 label=Samsung
  DiskInfo{disk:179,0}:
    flags=DEFAULT_PRIMARY|SD size=3909091328 label=

Volumes:
  VolumeInfo{emulated:179,130}:
    type=EMULATED diskId=null partGuid=null mountFlags=0 mountUserId=-1 state=UNMOUNTED
    fsType=null fsUuid=null fsLabel=null
    path=null internalPath=null mtpIndex=3
  VolumeInfo{private:179,130}:
    type=PRIVATE diskId=disk:179,128 partGuid=690A1A45-1078-BBCB-1327-6C05B4DFA287 mountFlags=0 mountUserId=-1 state=MOUNTED
    fsType=ext4 fsUuid=585061cc-3b08-489c-bf0f-030720c93036 fsLabel=
    path=/mnt/expand/585061cc-3b08-489c-bf0f-030720c93036 internalPath=null mtpIndex=2
  VolumeInfo{public:179,17}:
    type=PUBLIC diskId=disk:179,0 partGuid=null mountFlags=0 mountUserId=0 state=MOUNTED
    fsType=vfat fsUuid=0661-0905 fsLabel=
    path=/storage/0661-0905 internalPath=/mnt/media_rw/0661-0905 mtpIndex=1
  VolumeInfo{emulated}:
    type=EMULATED diskId=null partGuid=null mountFlags=PRIMARY|VISIBLE mountUserId=-1 state=MOUNTED
    fsType=null fsUuid=null fsLabel=null
    path=/storage/emulated internalPath=/data/media mtpIndex=0
```

```
root@4560MMX_sprout:/ # df
df
Filesystem               Size     Used     Free   Blksize
/dev                   479.6M    56.0K   479.6M   4096
/sys/fs/cgroup         479.6M    12.0K   479.6M   4096
/mnt                   479.6M     0.0K   479.6M   4096
/system                787.4M   409.3M   378.1M   4096
/data                    2.0G   166.9M     1.8G   4096
/cache                 122.0M    64.0K   121.9M   4096
/protect_f               5.8M    56.0K     5.8M   4096
/protect_s               5.8M    52.0K     5.8M   4096
/oem                    59.0M    44.0K    58.9M   4096
/storage               479.6M     0.0K   479.6M   4096
/mnt/runtime_default/emulated     2.0G   166.9M     1.8G   4096
/storage/emulated        2.0G   166.9M     1.8G   4096
/mnt/runtime_read/emulated     2.0G   166.9M     1.8G   4096
/mnt/runtime_write/emulated     2.0G   166.9M     1.8G   4096
/mnt/media_rw/0661-0905   255.9M    88.0K   255.8M   8192
/mnt/expand/585061cc-3b08-489c-bf0f-030720c93036     1.8G     2.8M     1.8G   4096
root@4560MMX_sprout:/ #
```

-

- Choose the emulated external sdcard to primary by “migrate data”
  - Its mountFlag is PRIMARY, and mount path is /storage/585061cc-3b08-489c-bf0f-030720c93036

```
root@4560MMX_sprout:/ # dumpsys mount
dumpsys mount
Disks:
  DiskInfo{disk:179,128}:
    flags=ADOPTABLE|SD size=2002780160 label=Samsung
  DiskInfo{disk:179,0}:
    flags=DEFAULT_PRIMARY|SD size=3909091328 label=

Volumes:
  VolumeInfo{emulated:179,130}:
    type=EMULATED diskId=null partGuid=null mountFlags=PRIMARY|VISIBLE mountUserId=-1 state=MOUNTED
    fsType=null fsUuid=null fsLabel=null
    path=/storage/585061cc-3b08-489c-bf0f-030720c93036 internalPath=/mnt/expand/585061cc-3b08-489c-bf0f-030720c93036/media mtpIndex=4
  VolumeInfo{private:179,130}:
    type=PRIVATE diskId=disk:179,128 partGuid=690A1A45-1078-BBCB-1327-6C05B4DFA287 mountFlags=0 mountUserId=-1 state=MOUNTED
    fsType=ext4 fsUuid=585061cc-3b08-489c-bf0f-030720c93036 fsLabel=
    path=/mnt/expand/585061cc-3b08-489c-bf0f-030720c93036 internalPath=null mtpIndex=2
  VolumeInfo{public:179,17}:
    type=PUBLIC diskId=disk:179,0 partGuid=null mountFlags=0 mountUserId=0 state=MOUNTED
    fsType=vfat fsUuid=0661-0905 fsLabel=
    path=/storage/0661-0905 internalPath=/mnt/media_rw/0661-0905 mtpIndex=1
  VolumeInfo{emulated}:
    type=EMULATED diskId=null partGuid=null mountFlags=0 mountUserId=-1 state=UNMOUNTED
    fsType=null fsUuid=null fsLabel=null
    path=null internalPath=null mtpIndex=0
```

```
root@4560MMX_sprout:/ # df
df
Filesystem               Size     Used     Free   Blksize
/dev                   479.6M    56.0K   479.6M   4096
/sys/fs/cgroup         479.6M    12.0K   479.6M   4096
/mnt                   479.6M     0.0K   479.6M   4096
/system                787.4M   409.3M   378.1M   4096
/data                    2.0G   166.9M     1.8G   4096
/cache                 122.0M    64.0K   121.9M   4096
/protect_f               5.8M    56.0K     5.8M   4096
/protect_s               5.8M    52.0K     5.8M   4096
/oem                    59.0M    44.0K    58.9M   4096
/storage               479.6M     0.0K   479.6M   4096
/mnt/media_rw/0661-0905   255.9M    88.0K   255.8M   8192
/mnt/expand/585061cc-3b08-489c-bf0f-030720c93036     1.8G     2.8M     1.8G   4096
/mnt/runtime_default/585061cc-3b08-489c-bf0f-030720c93036     1.8G     2.8M     1.8G   4096
/storage/585061cc-3b08-489c-bf0f-030720c93036     1.8G     2.8M     1.8G   4096
/mnt/runtime_read/585061cc-3b08-489c-bf0f-030720c93036     1.8G     2.8M     1.8G   4096
/mnt/runtime_write/585061cc-3b08-489c-bf0f-030720c93036     1.8G     2.8M     1.8G   4096
```

7 MTK Features

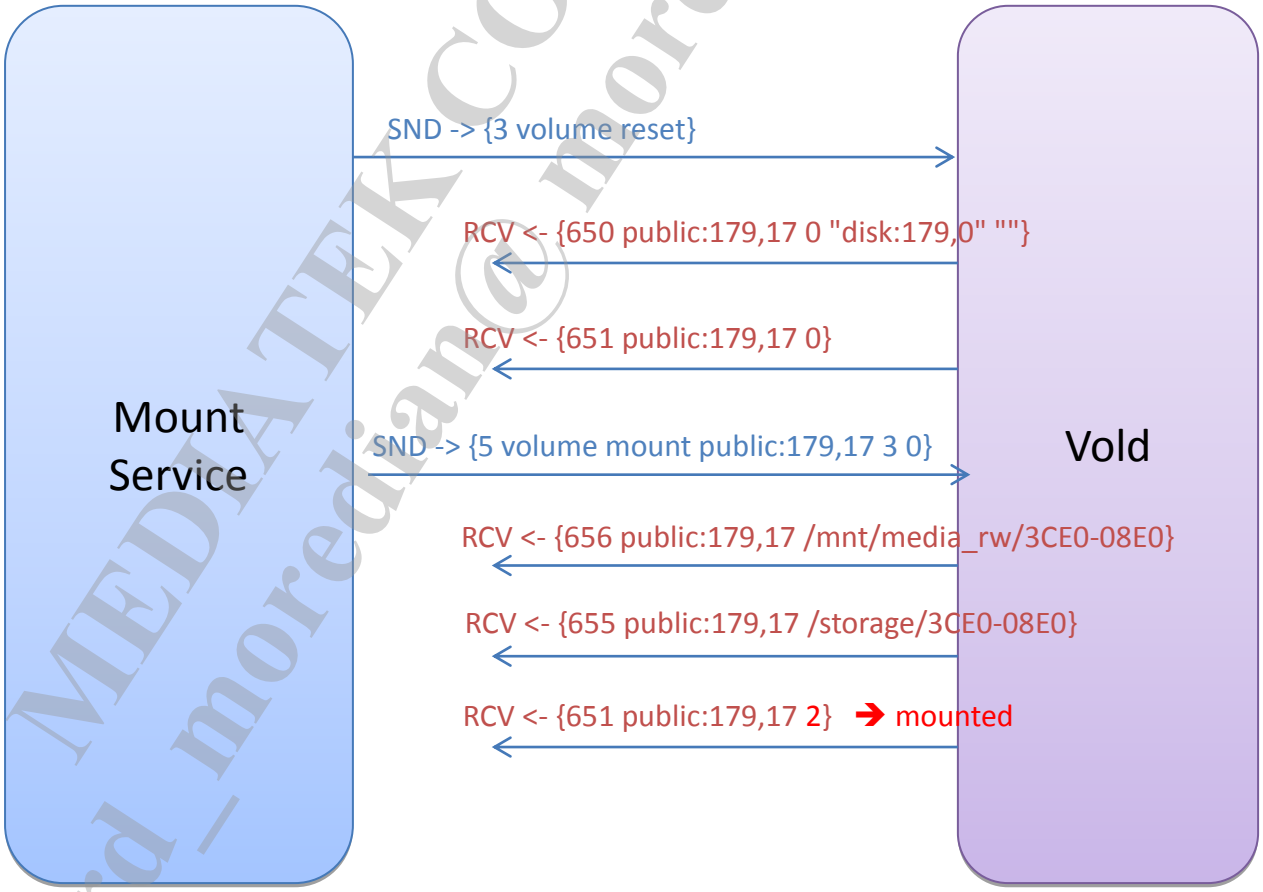
	MTK_SHARED_SDCARD	MTK_2SDCARD_SWAP	MTK_FAT_ON_NAND
Function	Emulated /data/media as ‘storage’	set ‘External sd’ to primary storage	Reserve a FAT partition as phone storage for NAND project
Status in M	Support However it only means different partition layout('intsd' partitiion exist or not)	Removed completely	Support
Description	In M, the user always can emulate /data/media as storage by ‘migrate data’	It is replaced by 'Adoptable Storage' feature. The external storage can be adopted and become primary storage	The size of the FAT partition is small. In order to get more size for storages, the user needs to adopt the external sd as primary
Note			

8 Detail

8.1 Mount Flow

```
static const int VolumeCreated = 650;
static const int VolumeStateChanged = 651;
static const int VolumeFsTypeChanged = 652;
static const int VolumeFsUuidChanged = 653;
static const int VolumeFsLabelChanged = 654;
static const int VolumePathChanged = 655;
static const int VolumeInternalPathChanged = 656;
static const int VolumeDestroyed = 659;
```

```
enum class State {
    kUnmounted = 0,
    kChecking,
    kMounted,
    kMountedReadOnly,
    kFormatting,
    kEjecting,
    kUnmountable,
    kRemoved,
    kBadRemoval,
};
```



8.2 Primary Storage

- Primary storage is set by property, ro.vold.primary_physical
  - It is set in init.[platform].rc

```
# sprout storage specific rc file.

import /init.sprout_common.rc

on init
    # Support legacy paths
    symlink /sdcard /mnt/sdcard
    symlink /sdcard /storage/sdcard0

    # By default, primary storage is physical
    setprop ro.vold.primary_physical 1
```

- If false, the emulated storage(/data/media) is primary
- If true, the storage with flag 'noemulatedsd' in fstab.xxx is primary