Research Paper Engineering

Modem Aggregated Functions Invocation By Layer-4 Intelligence

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ABSTRACT

The Object Oriented Systems Radio Interface Layer (OOS RIL) like android, windows and iOS, Customer-AT And windows messenger provides the similar functionality with same level of abstraction. And these components expect the higher level of abstraction then the modem platform APIs.Modem aggregated function invocation by layer-4 Intelligence fills the gap of modem telephony layer-4 functionality. This layer needs to build the telephony state machines and layer-4 logic around these state machines. And Modem aggregated function invocation layer exposes this functionality through the controlled APIs.

KEYWORDS Customer-AT commands, RPC, RIL, C language.

I.INTRODUCTION

Now is the era of "smart phones", there are essentially two processors in smart phones. Application processor where operating systems like android, iOS, windows etc, installed and along with user interface. Communication processor where all the GSM and all high-tech inter communication magic will happen.

In the most of modern smart phones the application processor, baseband processor and all the peripheral devises like microcontroller, memory blocks, RTC, UARTs, SPI, I2C, USB ports, SD/MMC card controllers and an ISO7816 SIM card reader etc, are integrated to one device/hardware called Smartphone or System on a Chipas shown in Figure1.

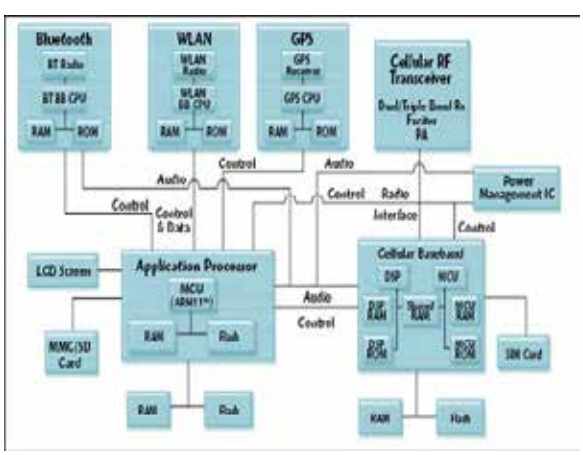

Figure 1 *Smart Phone Architecture*

However, to maintain the layered structure of hardware, the Application processor and Communication processor still communicates via UART (serial line), USB, and SPI or through shared memory (RAM) and/or a combination of these. To communicate directly with communication processor there will be always be some path that directlyaccessible from outside. Exactly how this is done, is mostly unknown due to the closed source and protectionist nature of the SoC manufacturers, to the great dismay of the developer community.

There are several methods of controlling and invoking the modem applications like Customer-AT commands, Radio Interface layer (RIL), Remote procedure calls (RPC) or Windows messengers.

The Object Oriented Systems Radio Interface Layer (OOS RIL) like android, windows and so on, Customer-AT and Windows messenger provides the similar functionality with same level of abstraction. And these components expect the higher level of abstraction then the modem platform API's.

Due to this gap, all these components end up with the duplication of functions. To fill this gap, needs a modem middleware component on top of platform API's i.e. 'Modem Aggregate Function Invocation by Layer-4 Intelligence'.

Customer-AT commands:

C-AT commands are used to control modem. Customer-ATtention is the abbreviation of C-AT. "AT" is the prefix that informs the modem about the start of a command line. It is not part of the AT command name.

Here are some of the tasks that can be done using AT commands with a GSM/GPRS modem or mobile phone:

- Establish a data connection or voice connection to a remote modem (ATD, ATA, etc).
- Send and receive fax (ATD,ATA,AT+F*)
- Write(AT+CPBW), Read (AT+CPBR) and Find(AT+CPBF) from phonebook entries

Radio Interface Layer

The AOS provide support for this framework in the Radio Interface Layer (RIL), which acts as the interface betweenthe radio HW and the Java Application Programming Interface (API). However, the RIL is divided into 4 parts or layers as shown in figure 2.

L3. RIL is available to all except some commands. L2. The RIL Daemon (RILJ) is an interface between Android Operating System and the Vendor RIL.

L1. The Vendor RIL, which is a closed-source and HW-specific implementation.

L0. The Vendor RIL modem HW and firmware then acts on the Layer-1 Customer-AT Commands.

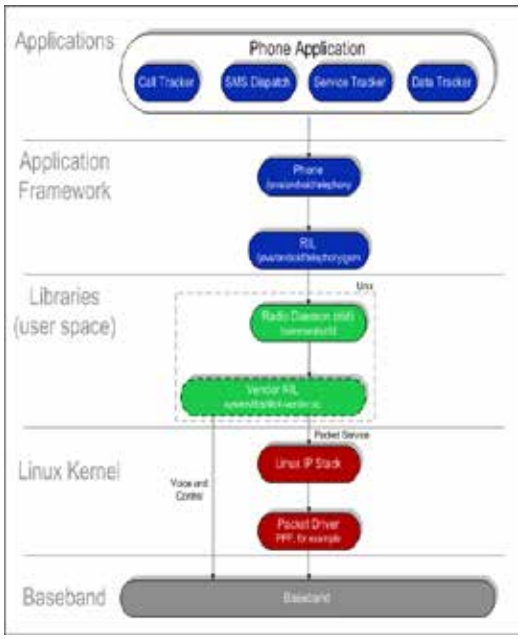

Figure 2: RIL Architecture

II. DESCRIPTION OF THE SYSTEM

A. *PROPOSED SYSTEM*

"Modem Aggregated Functions Invocation by Layer-4 Intelligence" is a layer newly introduced between the application layer and communication layer which fills the gap of modem telephony layer-4 functionality. This layer needs to build the telephony state machines and layer-4 logic around these state machines. This Modem aggregated function invocation layer exposes the functionality through the controlled APIs as shown in Figure 3.

B. *IMPLEMENTATION PROPOSAL*

Modem aggregated function invocation by layer-4 Intelligence provides the Layer-4 functional APIs.

This layer majorly contains the two sub components:

1. *State management layer*
2. *Logic Layer*

State management layer:This sub component builds and manages the telephony state machinesand all components will be give a registered id called context-id and this will be fixed throughout the process.State management layer maintains the table which contains the response callbacks for each request and indication callbacks.

Logic Layer:This sub component builds the modem aggregated function invocation layer 4 functional use case by using the state management layer.

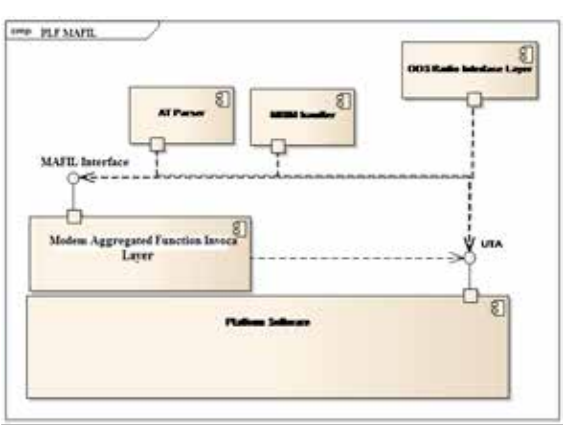

Figure 3: *Overview of MAFIL*

POSSIBLE SOLUTIONS FOR IMLEMENTING MAFIL

We can implement the proposed system MAFIL -4 Intelligence in three different ways we will discuss each of them with their advantages and disadvantages.

Solution 1:Building the Layer-4 components independent of each other

Independently all the modem application components and OOS RILs(Android, windows, Tizen and etc..) can implement the whole functionality on top of the platform interfaces as shown in Figure 4.

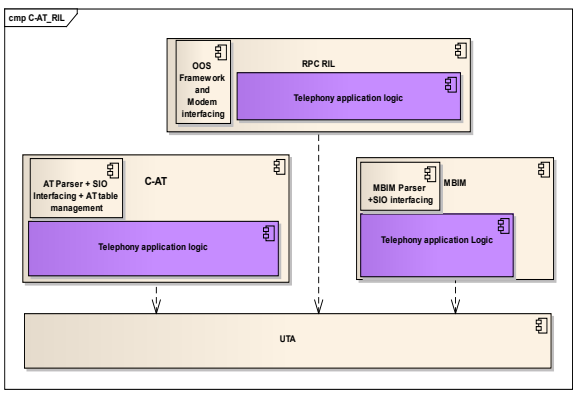

Figure 4: Solution 1

Disadvantages:

1. No reusability of code.
2. Code duplication across the components.
3. All components needs to go through stability cycle.

Advantages:

1. *No advantages.*

Solution 2:Introducing the new application middleware component in the Modem scope

Introduction of the new application middleware component in the system by considering the required Layer-4 functionality, so that all these components can be re-used the functionality from the new component.Thiscomponent will be implemented from the scratch. As shown in Figure 5.

Rank	Criterion	Solution 1	Solution 2	Solution 3
1	Reusability	Low	High	High
2	Stability	High	Low	High
3	Efforts	High	High	Low

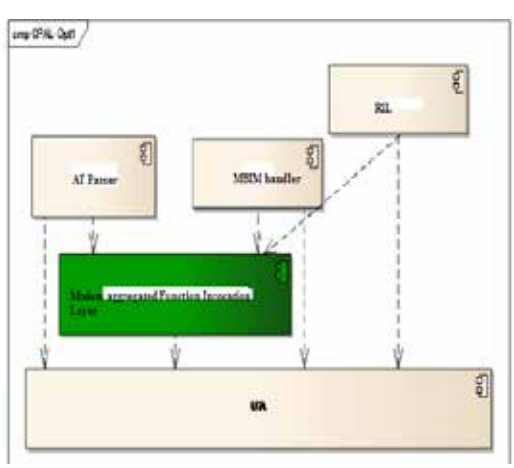

Figure 5: Solution 2

Advantages:
1.No Code duplication across these components
2.More cleaner approach

Disadvantages:
1. *Its takes time to mature and stabilize*
2. *Stability of C-AT and other stable components will be effected heavily*
3. *Huge development efforts*

Solution-3: Introducing the new application middleware component in the system by considering the common re-usable parts from exiting stable components
C-AT is one of the stable components and cleanly modular across the vertical functional domains. C-AT already exposed the logic layer APIs to the AT parser as internal C-AT APIs, these APIs are independent of AT semantics. This particular layer can be plugged out from C-AT and build the base for 'Modem aggregated function invocation layer'. As shown in Figure 6.

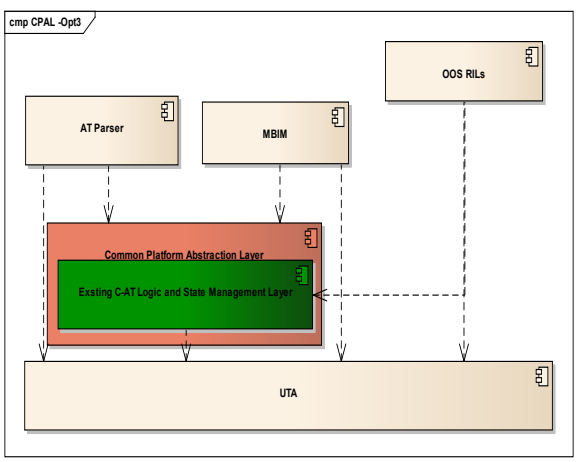

Figure 6: Solution-3

Advantages:
1. *No Code duplication across these components*
2. *The benefits of this approach would be to leverage on already stable & tested functionality*

Disadvantages:
1. *MBIM handler and RPC RIL need to move to new MAFIL-4 APIs.*

Evaluation Criteria
The reusability, how much the code can be re used to avoid duplication is one of the criteria. Stability after changing the methodology whether they will affect the existing methods or not. Effort the number of person required to implement the selected solution. The below table Table-1 shows the evaluation criteria.

Table 1 Evaluation Criteria
Based on above criteria **Solution 3** is selected for implementation.

C PSEUDO CODE
This pseudo code tells how the clients of MAFIL will requests the MAFIL.

Begin If modem is in off mode Start the modem If MAFIL is not busy Fill the parameters required for performing the activities.

Validate the parameters If all parameters are correct Send request to MAFIL
Else
Return the error
Else
Wait for MAFIL to be Idle
End

Begin
If client-id is valid
If MAFIL is in idle state
Validate the request
If success
Send the request to Protocol Stack
Validate Protocol Stack request
If Success
Return Success
Else
Return Error code
Else
Return Error code
Else
Return Error code
Else
Return Error code
End

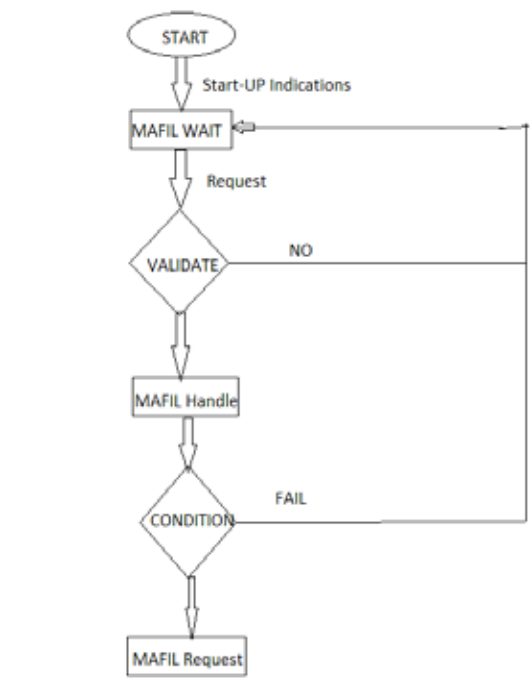

Figure 7: Clients of MAFIL requests

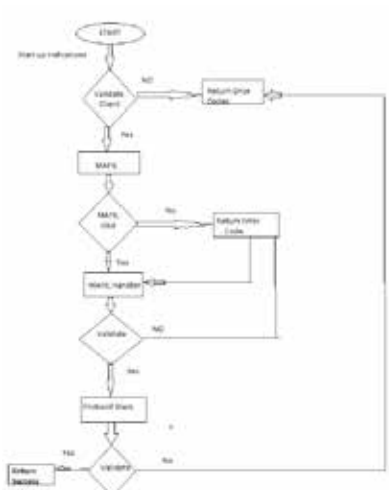

Figure 8: MAFIL requests PS

IV. RESULTS AND DISCUSSIONS

V. CONCLUSIONS

The process of communication is very important between in the processor is very important in mobile devices has wide scope for enhancements. Be it reduction in time, lowering power consumption, efficient memory utilization etc. There is always a scope and need for improvements. These enhancements have direct impact on the quality and longevity of mobile devices in the global market. The proposed work, Modem Aggregated Function Invocation by layer-4 intelligence, provides higher level of abstraction without any duplication, Provides the application specific APIs with higher granularity then the platform APIs, Not intended to replace/hide the platform APIs and Scope of these APIs is to promote the re- usability across the application components. Instead of making all the logical activities in one module like clients of MAFIL it is distributed to MAFIL also. Maintenance is reduces as by centralizing the core functionalities. Since there are many clients to MAFIL all the core functionalities are moved to MAFIL instead of keeping at the clients of MAFIL. Optimized memory usage if we are using multiple clients.

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