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Research paper

Framework Enhancement for Common Public Radio Interface in SBTS

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Abstract

There is a rapid growth of mobile users so there are developing more number of features by a service provider to support more number of mobile users. The Common Public Radio Interface (CPRI) is an interface between the Radio Equipment Controller (REC) and Radio Equipment (RE) to support more number of users. This simplifies the overall architecture of radio base station. The radio base station is centralized and the radio heads are distributed in the environment. This radio heads supports the more number of users. The main aim of CPRI is to divide the packets into number of frames. The radio frame is divided into the hyper frames and this hyper frame is divided into the number of basic frame in which each basic frame is supported up to 16 words totally it supports up to 6,144 megabytes per second.

Keywords: *CPRI, REC, RE, Radio Frames and Hyper Frame.*

1. Introduction

A cellular network is the wireless communication network. The network is distributed as many small cells in a land area. For at least three cell there is one fixed location called transceiver for serving these cells. For each cell, there is a station. The base station provides the cells for the communications between the mobile devices or with the other cells. The cells have different frequencies with the neighboring cells to avoid an interference for the communication. When we combine these cells, we will get a wide range coverage of radio access network for the geographical area. For an efficient coverage, along with the fixed transceivers we need to have some portable transceivers for an efficient communication. Some of the transceivers moves as the cell moves.

The most common example of cellular network is mobile phone network. A mobile phone is a portable device which is used to transfer a data from one device to another device via communication channel. For communication between these devices they use a cell. The radio waves are used to transfer a data to and from the mobile devices.

The mobile phones are used for coverage and capacity for subscription by the cellular networks. The vast space geographical notation is split into smaller cells to access more number of mobile users. All the cells connected to the switches in turn the switches connected to the public network.

There are number of different cellular technology like Global system for mobile communication (GSM), Universal mobile telecommunication system (UMTS), General packet radio service (GPRS) etc. But in many countries, they use a GSM technology for the efficient communication.

2. Literature Survey

In Common Pubic Radio Interface (CPRI) specification, the main functionality is traditional wireless base station is divided into different forms of subsystems that is Radio Equipment Controller (REC) and Radio Equipment (RE). Radio Equipment Controller is mainly responsible for wireless communication within the range of digital baseband signal whereas the Radio Equipment is responsible for wireless communication for both analog RF signal and digital baseband signals. Furthermore, the control messages must be synchronous between the REC and RE or between the two RE devices. User planes are connected with I/Q data mode. Different IQ data mode transmits the data via light or electricity and adopts the Time Division Multiplexing Amplifier (TDMA) mode [1].

In this [2], as the number of mobile users are increasing rapidly, then we have to deploy more number of antennas to satisfy the demand of growing bandwidth. So, it reduces the distances between the cell-sites. For doing this, they adopted a method called Distributed antenna system (DAS) or cloud radio access network (C-RAN). In order support communication between the REC and RE the Wavelength Division Multiplexing (WDM) is to increase the aggregation of the bandwidth to support more number of users. In CPRI, there is no limitation of use of specific topology means we can use any topology like star, ring, bus and point to point etc. They measured a bit rate control for every 20 kilo meters in single mode fiber.

Today we use electronic devices for all the things, it became day to day thing in our life. To support the testing of that large system we use TTCN-3 (Testing and test control notation version 3) scripting language. It was shown, the automated test systems written in TTCN-3 has better to be tested for complex systems [5].

In Industries, they use a Java program for writing the code which as circular dependencies to check the code and it's very difficult to understand the modules of the features. So, to easily understand the program and test the program we can go for TTCN-3 language.

3. Proposed Methodology

The CPRI is an interface between the Radio Equipment and Radio Equipment Controller with in the radio base station. This CPRI includes user data, control and management plane. This CPRI aims for the hardware dependency layers they are physical layer and
data link layer. This feature is developed for a point to point interface only because it supports robust and efficient utilization of the hardware device.

The main specification of CPRI are as follows:
1. A continuous or discrete internal interface in the radio base station establishes a connection between the Radio Equipment (RE) and Radio Equipment Controller (REC) enables both the topologies either it may be single hop or multiple hop.
2. It supports user plane data, synchronization of data and control and management plane data.
3. The physical layer support both optical and electrical interfaces and the data link layer supports scalability and flexibility.

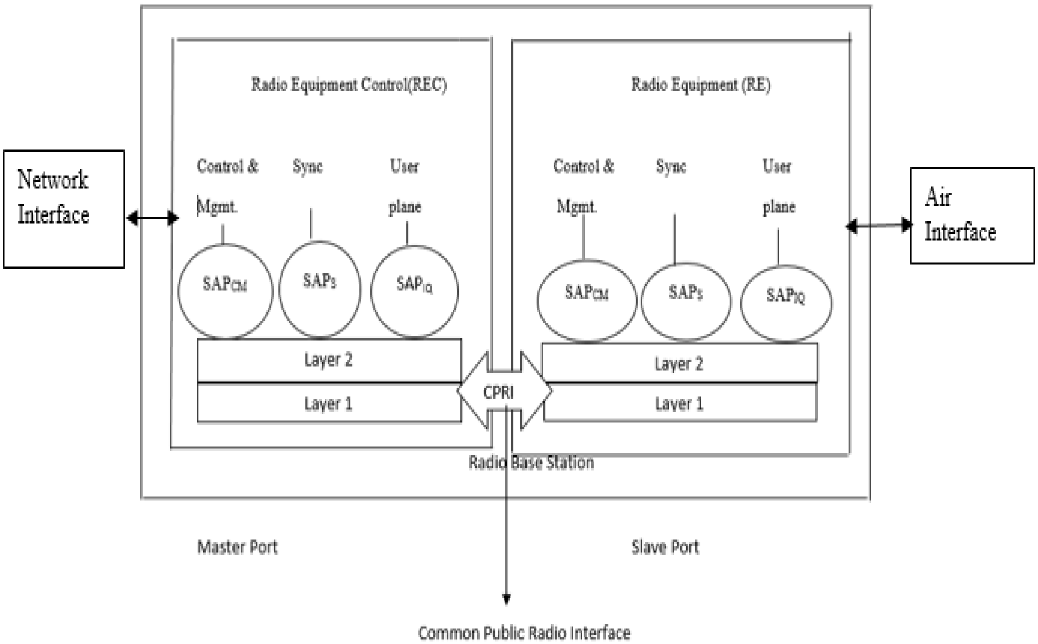

Fig. 1: CPRI Specification and interfaces

Control Plane: It is responsible for controlling the data flow used for processing.
Management Plane: This contains a management information for operation and management of CPRI link and between the REC and RE.
User Plane: Data that has to be transferred from mobile devices to radio base station or radio base station to the mobile devices.
Synchronization: The flow of data between the nodes should be synchronized and timely manner.

A. Modules of CPRI

The complete CPRI feature is divided into three parts from GTS operation and management point of view:
1. CPRI support for GSM
2. Testability support for GSM
3. SRT support for GSM

CPRI support for GSM: CPRI interface as the first interface that will be supported on a Rel-5 radio, as this interface is more efficient compared to OBSAI interface in most of the configurations. DSP will convert the OBSAI frame into CPRI frame for all traffic and control data if that TRX is allocated or data going through Rel 5 Radio Module. (Legacy RFM is in chain behind CPRI based RFM).
Testability support for GSM: In SBTS, GSM need to support the testability from WebEM or BSC. It can be possible in either Network Mode or Test Dedicated State(TDS) Mode. It includes following test commands. Later scope gets changed by PdM and Prog management and now only TDS mode testability is supported from SRT.
1. TRX test from WebEM or BSC (Network Mode/ TDS mode)
2. TRX Loop test from SRT. (TDS mode)
3. BCCH Transmission test from SRT (TDS mode)
4. TRX Continuous test from WebEM (Network Mode)
5. TRX Test Pattern from SRT (TDS Mode)

SRT support for GSM: SBTS needs to support below commands run from SRT tool for GTS purpose. Other commands will be handle by common O&M. Few testability related commands are already handle in above testability scope.
1. TRX Reset command
2. Set TRX PRBS SEED command
3. Set per TRX power command
4. Multiple TRX loop test command (It will be same as TRX loop command but runs on multiple TRXs)

B. Functional Description of CPRI

Radio Functionality: This functionality gives a detail idea about how the split is taken between the REC and RE. The REC consists of digital baseband processing, the interface between the network and transport layer and the control and management function for the radio base station. The REC is responsible for functions like filtering, amplifying, modulation and conversion of frequencies.
CPRI Control Functionality: The radio equipment controller's main functionality is to manage the topologies used in CPRI. The radio equipment controller can also have the radio equipment layer. The radio equipment functionality is used to manage the forwarding of the data, switching across many intermediate devices and also cross connecting between the radio equipment and SAP.

4. System Design

The figure 2 below shows the architecture of GTS in CPRI. There are three interfaces in GTS to establish a connection with BSC where actual CPRI layer is introduced inside the BSC between layer1 and layer2.

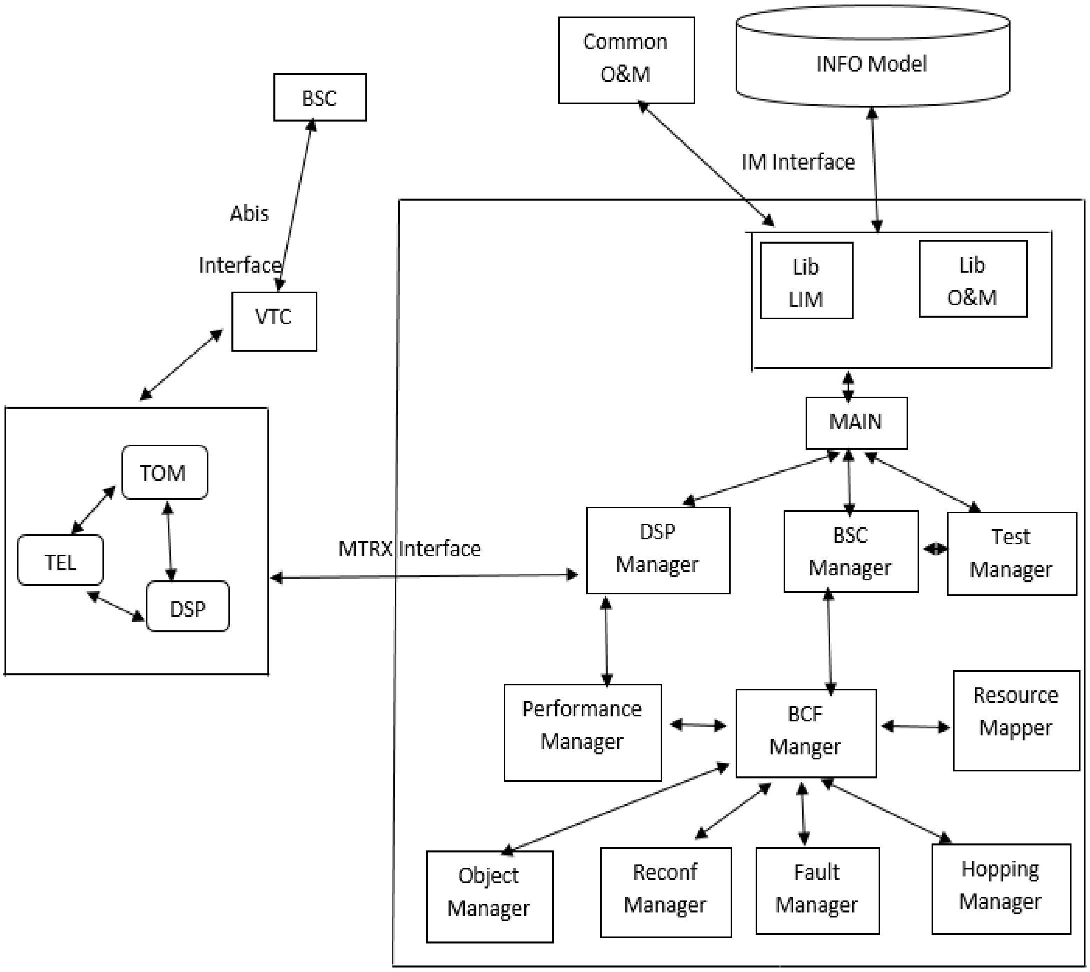

Fig. 2: Architecture of GTS

Abis Interface: The Interface between the Base Station Controller and Base Transceiver station is called as an abis interface. For transmission of data it uses a SCTP protocol. It uses SCTP because it is reliable and transmission control protocol.

Mtrx Interface: The Interface between TRX on module and system on module is called as an Mtrx interface. This interface is used to exchange the configuration messages between them. It also used to exchange the status, alarm and request managed object responses.

IM Interface: The IM Interface is the interface between the IM commander and GTS system. This is the interface to fill the IM commander and this IM Commander can be the basis for testing in K3 for system component testing (SCT) and plain integration testing (PIT).

Apart from the interfaces there are many other components that is required inside the GTS to support a CPRI feature, they are as follows:

DSP Manager: The digital signal processing component provides the power that is required for computing for several processing tasks like base band processing.

BSC Manager: As the name indicates that it controls the overall base station system that is it invokes the BCF manager for creating some objects, fault management, hopping management and also for an reconfiguration.

Test Manager: The test manager is responsible for invoking the particular tests in sct and pit and check all the possible scenarios for the particular feature and make the verdict as pass or fail based on the scenario of the test case.

Performance Manager: The function of performance manager is to monitor the network communication. It verifies the telecommunication network it may be physical or logical network. It provides optimal communication services for the mobile users.

BCF Manger: It is also called as a configuration manager which is responsible for the configuration of the network resource for optimal communication between the mobile users. The BCF manager is responsible for initializing the low-level devices for exchanging the configuration messages.

Resource Mapper: The resource mapper is responsible for allocating the network resources for the components for efficient communication. It supports bot statistical and dynamic allocation of resources. The allocation of resources is used mainly for sector level and trx level allocation.

Object Manager: The object manager covers all the functionalities for the software and the hardware configurations. It is the one which is responsible for handling the centralized data from base controller. It is also responsible for locking and unlocking the particular trx in the sector or locking the whole sector. It is also responsible for blocking or unblocking the sector or the trx in that particular sector.

Reconf Manager: In this we should first configure the configuration messages to the whole start up flow. Once it is said to be GTS system on air carrier level that is GTS is ready to receive the signals for communication.

We will tear down the tasks means we will break the communication medium logically and then again, we will lock or block then some IM expects are filled in IM commander and again the GTS messages are configured.

Fault Manager: Fault management is important in GTS system module, because whenever something happened inside the system the alarm should be raised. The fault manger is responsible for isolating and managing the faults in the network.

Hopping Manager: The hopping manager is responsible for the hopping configuration. There are five types of hopping they are non-hopping, antenna hopping, radio frequency hopping, baseband hopping and dfca hopping. These hoppings are reflected only in sectors but not at carrier groups. In this feature we are checking that if the sector is antenna hopping then all the trx id including BCCH trxid the dual uplink mode falag is set to true and for the other hopping mode all the trxid except the BCCH trx id should be set the dual uplink mode flag to one and the BCCH trxid should be have the dual uplink mode flag is set to zero. Usually the first trxid of every sector is BCCH trx that is 1st,4th and 9th trx. Whenever the hopping configuration is enabled we must send a negative acknowledgement to the BSC.

A CPRI Packet format

In CPRI the packet is divided into three forms, first the radio frame of length 150 where each packet in radio frame is divided into the hyper frames of length 256 further each hyper frame is divided into the basic frame which can support up to the 16 words each as shown in the figure 3. So, totally it can support up to 614400 bytes per 10 milli seconds.

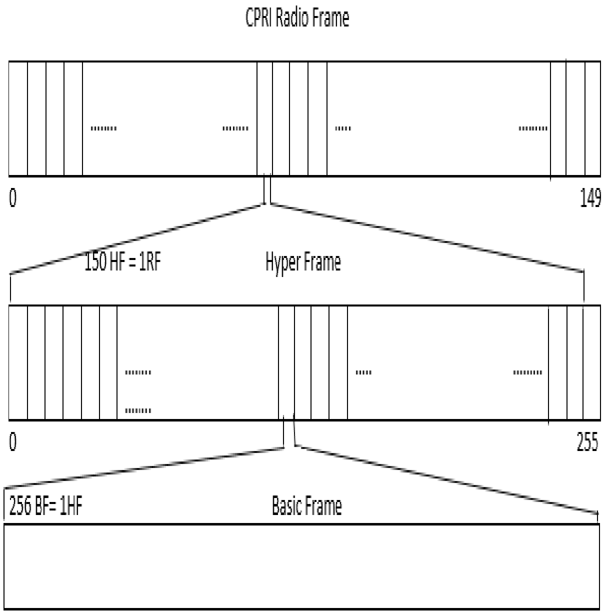

Fig. 3: CPRI Packet Format

5. Results and Discussions

The results obtained for the start-up scenario is described below:

1. Login into the Linux container to write and execute test cases. Each user's container is given an IP address. The BTS code is downloaded for testing.
2. We use simulation software component testing and plain integration testing tool for testing the different components and interfaces between the radio base station.
3. Before starting of execution, we have to prepare K3 environment, we have to give the following commands to run the testcase.

- source C_Test/k3setenv.env
- source C_Test/k3settools.env
- k3env reload
- prepareToolsAndPlugins.sh

4. Then we can execute the testcase by using tk3 sct_gts Testability "testcase name"
5. If the test case passed then below is the output of the testcase.

```
+ TC flow 1: Environment initialization succeeded. GTS is running and ready for testin
+ TC flow 2: SignIn SucessFull. GTS_L created at /MRBTS-1/RAT-1/GTS-1
+ TC flow 3: Mtrx Flow initiated
+ Startup flow 1: Set state received
+ Startup flow 2: Reset command msg received
+ Startup flow 3: Mtrx report indication with state Configuring sent
+ Startup flow 4: Constant Config Message recieved
+ Startup flow 5: Constant Config ACK Message sent
+ Startup flow 6: Dynamic Config Message recieved
+ Startup flow 7: Dynamic Config ACK Message sent
+ Startup flow 8: Composite cell Config Message recieved
+ Startup flow 9: Composite cell Config ACK Message Sent
+ Startup flow 10: Hop Config Message recieved
+ Startup flow 11: Hop Group Config Message recieved
+ Startup flow 12: Hop Group Config ACK Message sent
+ Startup flow 13: Rp3Address Config Message recieved
+ Startup flow 14: Rp3Address Config ACK Message sent
+ Startup flow 15: RSSI Correction Config Message recieved
+ Startup flow 16: RSSI Correction Config ACK Message sent
+ Startup flow 17: DTRX Enhancement Config Message recieved
+ Startup flow 18: DTRX Enhancement Config ACK Message sent
+ Startup flow 19: PRBS CFG Message received
+ Startup flow 20: PRBS CFG ACK Message sent
+ Startup flow 21: OSC  CFG Message received
+ Startup flow 22: Rf resource allocate cmd message sent
+ Startup flow 23: Rf resource allocate cmd ack message received
+ Startup flow 24: Bcch power level curr Message sent
+ Startup flow 25: BCCH Power Level Update recieved
+ Startup flow 26: Dynamic Config Message recieved
+ Startup flow 27: Dynamic Config ACK Message sent
+ Startup flow 28: Test request ack Message sent
+ Startup flow 29: Test request ack Message sent second time
+ Startup flow 30: Rf resource release cmd message sent
+ Startup flow 31: Rf Resource Release Cmd Ack Message recieved

Checking testcase flow done (took 286 ms)
Checking verdict
Verdict: PASS (took 246 ms)
Running log analysis
--- Found sct_gts_K3.log

@@@ Test case status --> PASS
```

Fig. 4: Execution Success of CPRI

6. The Syslog and sct_gts logs are analyzed.
7. The IM Commander for corresponding output is as shown below in the figure 4. The IM Commander is used to check whether we are filling all the managed objects for the corresponding CPRI feature.

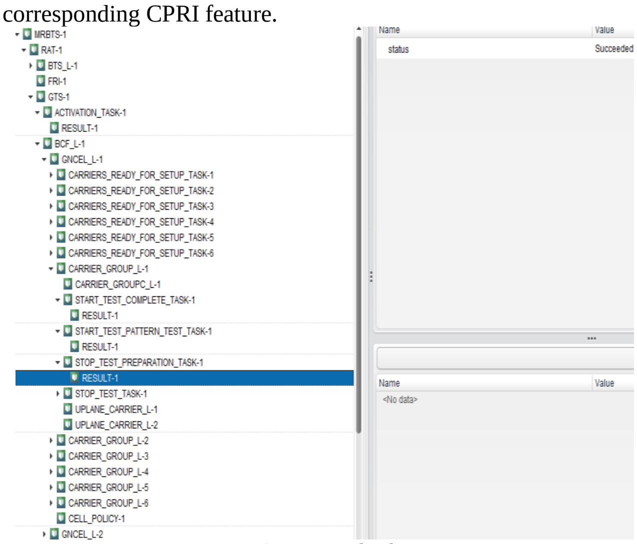

Fig. 5: IM Check

8. After the testcases are passed then we should raise the Merge Request (MR) in the gerrit polling
9. Once the MR is ready to merge, we can check in our code into the git Continuous Integration (CI), which is the master storage which has all files and their history.
10. Once it is successfully merged to the git then we should merge to the svn tortoise.
11. The check in should be successful once the check in is taking the time within 10 minutes and the build should be passed.
12. If the build is failed because of our code check in then the BTS team will revert back the code, we can track the check in code by using a revision number.

6. Conclusion and Future Scope

As there is rapid growth in the mobile communication there is also increase in the more number of mobile users. So, to support more number of users we developed an interface called Common Public Radio Interface (CPRI) is an interface between the system module and radio module. The interface is provided between the layer1 and layer2 in the radio base station to support more number of users. The CPRI can be used for all relevant 3G and future standards. It simplifies the base station architecture. There is a centralized radio base station and there are number of remote heads distributed in the environment to support more number of users. The CPRI radio frame is divided into the hyper frame and this hyper frame is divided into basic frame of 16 words which receive or send the data based on the direction of the link. So, 1 basic frame has 16 words, 1 hyper frame has 256 basic frames and 1 CPRI radio frame has 150 hyper frames. So, totally it can support up to 614400 bytes per 10 milli seconds.

In future, we are focus on the testability feature for the real hardware tester. In testability we can provide a web user interface where he can access this web user interface for checking a hardware. In testability it is easy to test the hardware than compare to testing a real hardware by making calls and checking whether the trx is in loop test and checking the states radio frequency is ready to receive the signal and the trx is in BCCH supervisory state.

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