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***Research Paper***

# An enhanced distributed evolved node-b architecture in 5G tele-communications network

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**Abstract**

To meet the regularly expanding versatile information movement request, the portable administrators are conveying a heterogeneous system with numerous entrance innovations and an ever-increasing number of base stations to build the system scope and limit. Be that as it may, the base stations are disconnected from each other, so unique sorts of radio assets and equipment assets can't be shared and dispensed inside the general system agreeably. The versatile administrators are in this manner confronting expanding system operational costs and a high framework control utilization. In this paper, a brought together radio access organize design, alluded to as the super base station (super BS), is proposed, as a conceivable answer for a vitality productive fifth-age (5G) versatile framework. The super base station decouples the coherent capacities and physical elements of conventional base stations, so unique sorts of framework assets can be on a level plane shared and factually multiplexed among all the virtual base stations all through the whole framework. The framework structure and principle functionalities of the super BS are portrayed. Some key advances for framework usage, i.e., the asset pooling, continuous virtualization, versatile equipment asset assignment are likewise featured.

## 1. Introduction

With the fast advancement of PDAs and portable web applications, versatile clients require consistently expanding remote transmission information rates. As indicated by the CISCO Visual Network Index (VNI) report, the worldwide portable information movement will expand 13-overlap in the vicinity of 2012 and 2017, developing at a compound yearly development rate of 66%, and achieving 11.2 exa bytes every month by 2017 [1]. To meet the touchy versatile information activity request, different measures have been taken to improve the framework limit, for example, more range, littler cells, utilizing propelled remote technologies, for example, orthogonal recurrence division multiplexing (OFDM) [2] and various info numerous yield (MIMO). By the by, the pinnacle information rate from 2G to 4G framework has just expanded at a compound yearly development rate of 55% [1]. There is a major hole between the movement request and system limit and the hole is further developing.

In future 5G portable correspondence frameworks, various promising methods have been proposed to help a three requests of extent higher system stack contrasted with what administrators are encountering today. One conceivable approach is to expand the thickness of remote access focuses [3]. Be that as it may, if the regular portable system design in view of circulated base stations (Evolved Node B) is utilized, increasingly Evolved Node B will be required, which brings versatile administrators enormous difficulties, for example, a quickly expanding system operational cost caused by the development, keeping up and control utilization of countless; serious between cell obstruction, because of the thick sediment of Evolved Node B, which are consistently free of each other without full collaboration; low framework equipment asset use rate. Note that under current system engineering, every Evolved Node B must be composed with high ability to help the greatest conceivable movement stack in its phone. At the point when the movement stack is low, the majority of the limit is squandered, in light of the fact that the hard-product asset of Evolved Node B, for example, calculation and memory limit, can't be shared among various Evolved Node B since they are secluded from each other.

Clearly, a thick cell arrange in light of customary autonomous Evolved Node B isn't reasonable for 5G frameworks. Hence, a brought together cell arrange engineering has been proposed and it has turned into a hot research theme in both scholarly world and industry. China Mobile declared a brought together radio access organize engineering (C-RAN) in 2009 [4], which joins incorporated baseband pool handling, helpful radio with circulated receiving wires furnished with remote radio heads (RRHs), and ongoing cloud foundations. Following C-RAN, remote system cloud (WNC) [5] by IBM and Light Radio [6] by Alcatel-Lucent and Bells Labs are additionally proposed as conceivable answers for the future brought together remote systems. Also, a RAN advancement venture P-CRAN is set up by NGMN in 2011 [7] to contemplate the necessity, arrangement and institutionalization of C-RAN for a future radio access organize engineering giving upgraded operations, higher effectiveness and improved performance. The principle thought of these new designs is to decouple the radio recurrence (RF) and baseband handling capacities, which have been co-situated in conventional Evolved Node B. Just a RRH is situated in every cell site. The building baseband units, alluded to as BBUs, which play out the baseband handling capacities in customary Evolved Node B are presently amassed and moved into a centralized area, alluded to as the BBU pool. The RRHs are associated with the BBU pool through high data transmission optical systems. With this unified system engineering, the organize working expense and power utilization

can be diminished fundamentally because of the moderately straightforward situating of RRHs and minimal effort support of BBUs. The C-RAN arrange trial tests by China Mobile has demonstrated that the framework OPEX, CAPEX and power utilization with C-RAN diminished by half, 15%, and 71%, separately, contrasted with the individual esteems in a customary portable framework.

Albeit concentrated system models are promising for 5G frameworks, there are different difficulties if a substantial number of cells should be unified. One major test is to build a super-high limit BBU pool, which handles the baseband processing's for an extensive number of cells. In C-RAN, the BBU pool is sent on standard GPP stage, for example, the standard IT server with x86 engineering, and an extra devoted equipment quickening agent is likewise included every server for the calculation escalated physical layer processing's [8]. Customary IT-based virtual machines (VMs) are introduced on the servers, where various types of Evolved Node B can be effectively set up through a bound together open interface. Be that as it may, it is accounted for that lone 3– 6 LTE subcarriers can be handled by a standard server with a size of 2 rack units, with a moderately high power utilization, i.e., 80 Watts for every a LTE subcarrier, on the GPP based C-RAN BBU pool. Despite the fact that the computational ability of the GPP stage will increment and the normal power utilization will diminish step by step, driven by the Moores Law, there are additionally worries that GPPs and the customary IT virtualizations, which are initially composed and streamlined for non-continuous errands, will most likely be unable to fulfill the ongoing handling prerequisite of 5G frameworks [8].

In this paper, we show a coherently dispersed yet physically incorporated portable system design, alluded to as the super base station (Evolved Node B), for the 5G framework. The BBU pool is developed with computerized flag processors (DSPs) exhibits. The programmable DSPs have been broadly utilized in current correspondence frameworks with favorable circumstances, for example, low power utilization and high ability to deal with constant preparing. It is normal that in the DSP based Evolved Node B framework, a normal energy of 5– 10 Watts for each a LTE subcarrier can be accomplished in the BBU pool. In any case, contrasted with GPP based BBU pool, a major test for Evolved Node B is the means by which to deal with all the equipment assets, for example, registering assets and memories, in an adaptable, profoundly productive and constant way. A preparing level constant virtualization system is proposed in this paper for the equipment asset administration in the Evolved Node B. Straightforward deliberations of framework assets are first given. At that point at least one virtual Evolved Node B (VBSs) with various gauges are developed. The framework assets are straightforwardly allotted to these VBSs in a helpful and effective route by the concentrated asset administration focus, with no interference of working frameworks, so ongoing communication handling can be ensured. The fundamental contrasts and the execution correlation between the C-RAN and Evolved Node B are portrayed in Tab. 1

| Items | C-RAN | Evolved Node B |
|---|---|---|
| BBU | GPP Platform with | Reconfigurable |
| Component | Hardware accelerator | DSP |
| Virtualization | Traditional IT-based | A process- level |
| Technique | Virtualization | Virtualization |
| Performance per watt | Low | High |
| Real-time performance | Low | High |
| Openness of the interface | High | Low |

In the accompanying areas, we will initially give a comprehensive portrayal of the Evolved Node B framework design, trailed by the exchange of the key innovations in framework usage.

## 2. Evolved Node B Based Concentrated System Engineering for 5g Portable Frameworks

The concentrated system engineering in light of Evolved Node B is appeared in Fig. 1. Like C-RAN, it comprises of three primary parts: the dispersed RRHs situated at cell locales, the high limit and low dormancy optical system and the Evolved Node B. Additionally, the Evolved Node B is additionally partitioned into three sections: the superior multi-mode reconfigurable BBU pool in light of DSPs, the multi-mode higher layer convention handling unit (PPU) pool in view of GPPs, and the worldwide concentrated asset administration focus (GRMC).

The conveyed remote radio heads (RRHs) are reception apparatus clusters that comprise of multiband radio recurrence (RF) preparing units, which are sent precisely similarly as the receiving wires in customary Evolved Node B. All the RRHs are associated with the BBU pool by means of a high transmission capacity and low-inertness optical system, and a radio recurrence switch (RFS). Under the control of the GRMC, the mapping amongst RRHs and BBUs can be powerfully balanced by just changing the switch strategy. For instance, the uplink base-band I/Q information from a RRH are initially transmitted to the BBU pool as a contribution to the RFS. At that point the GRMC chooses the yield in the RFS, where the uplink information are sent to a relating BBU for additionally handling, considering the present working heap of all the BBUs in the BBU pool.

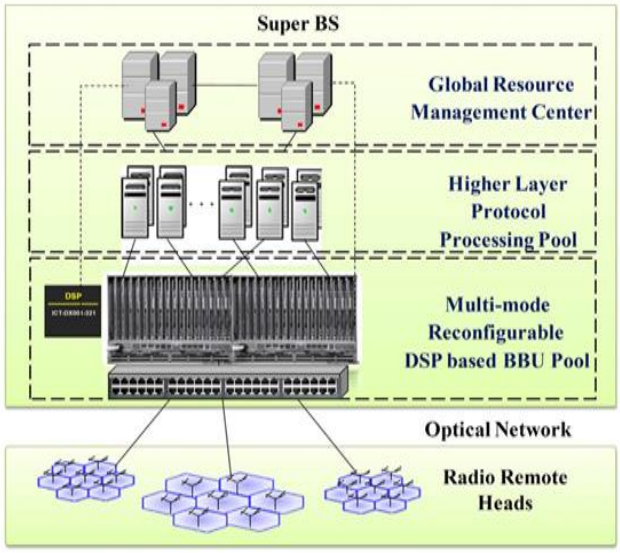


**Fig. 1:** Evolved Node B system architecture

Additionally, as per the cell stack, the GRMC can change the arrangements of RRHs, and kill on or change the RRHs to ensure the system scope in a vitality proficient way.

The Evolved Node B is the key of the new concentrated architecture for 5G versatile frameworks, where the intelligent capacities and physical elements in conventional Evolved Node B are decoupled. Diverse sorts of equipment assets, i.e., the radio wires, BBUs, PPUs and Evolved Node B administration units, are on a level plane shared. By utilizing the asset pooling and continuous virtualization technologies (depicted in Section 3), the Evolved Node B gives a straightforward reflection to these equipment assets and changes them into at least one intelligent elements. In this way, at least one VBSs with various principles can be effortlessly developed with these elements through a brought together and open interface.

In the Evolved Node B, the superior multi-mode reconfigurable BBU pool comprises of extensive scale programmable DSP exhibits, which play out the physical layer processing systems. With asset pooling and virtualization advancements, the BBUs are

shared among all the VBSs and can be powerfully distributed to various VBSs, in view of the necessities of VBSs, where the framework equipment asset can be completely used.
The multi-mode higher layer PPU pool alludes to an asset pool for the higher layer convention preparing, for example, Layer 2 and Layer 3 over the air interface. The PPU pool comprises of extensive scale GPP stages, for example, PowerPC, ARM processors and x86 servers, so the higher layer convention functionalities are executed as programming programs run-ning on GPPs. The projects for various conventions can be powerfully designed on each PPU by the GRMC, in light of framework arrangement approaches. The between associations between coherent convention preparing units and the baseband handling units take after standard remote interfaces, for example, Iub and Abis. Rapid 10-GbE is utilized to trade the gigantic convention information between the PPU and BBU pools.
The worldwide incorporated asset administration focus (GRMC) is the control focal point of the Evolved Node B framework. It decides the assignment of radio assets (i.e., time, range, power, space) and equipment assets (i.e., BBUs, PPUs) to each VBS. For instance, since the constant channel status data of every cell, for example, the heap data and channel quality, are altogether exchanged to the Evolved Node B, the progressed physical layer transmission techniques and asset administration plans, for example, CoMP and eICIC can be connected in an incorporated and helpful way, where the between cell impedance can be significantly diminished. Also, under the control of GRMC, the equipment assets can be progressively distributed to various VBSs as indicated by their movement stack profiles, where the equipment asset use is amplified. Through the joint radio asset and equipment asset portion, diverse sorts of framework assets can be overseen agreeably, where a future green, vitality effective remote system can be figured it out.

## 3. Key Technologies

As a lot of equipment gadgets are physically unified in the Evolved Node B, one of the key difficulties is to viably build the asset pool, for example, the BBU pool and PPU pool, where a high-data transfer capacity and low-inactivity interconnection between various equipment assets is given. Besides, how to powerfully develop diverse sorts of VBSs for the cells and assign the equipment assets in the brought together asset pools to the VBSs in view of their requests are the other two critical difficulties in the framework outline.

### 3.1 Large Scale Asset Pooling

In the Evolved Node B framework, there is no settled mapping between the equipment assets and VBSs. A lot of BBUs and PPUs are physically gathered together and shape the BBU and PPU pools, which empower the factual multiplexing and helpful assignment for various assets. Note that in current versatile frameworks, there are Evolved Node B items that different the RRH and BBU capacities, where the physical layer techniques from a gathering of Evolved Node B are prepared in a little size BBU pool [4]. Nonetheless, the mapping between the RRH and BBU is predefined and the equipment assets of various BBUs can't be progressively shared by various Evolved Node B. So the Evolved Node B is in a general sense not the same as these Evolved Node B items and new advances are expected to understand the asset pooling. Besides, as a lot of information (e.g., more than 10 Gbits/s) should be traded between various BBUs and PPUs inside a millisecond day and age, the transmission capacity and information trade inertness among the BBUs and PPUs are two most basic impediments when building the asset pool.
As appeared in Fig. 2, a 4-layer interconnection system is proposed to develop the BBU and PPU pools in the Evolved Node B. In light of the open smaller scale telecom figuring architecture (mTCA) and propelled telecom processing engineering (ATCA), a given number of BBUs/PPUs are first associated with a BBU/PPU board through PCIe interface. Diverse BBU/PPU loads up are at that point associated with each other through GbE rapid backplane and frame the BBU/PPU sub-pool. At long last, the BBU/PPU pool is developed by a few BBU/PPU sub-pools, where an extensive number of air interface convention information can be traded between various sub-pools through a 10 GbE optical fiber organize. By utilizing this 4-layer between association structure, a greatest of 20 Gbps throughput can be bolstered in a solitary BBU/PPU board with low idleness. Besides, by utilizing this open structure, the system administrators can undoubtedly extend framework limit by just developing and embeddings new asset pools in the framework, with no interference to current system administrations.

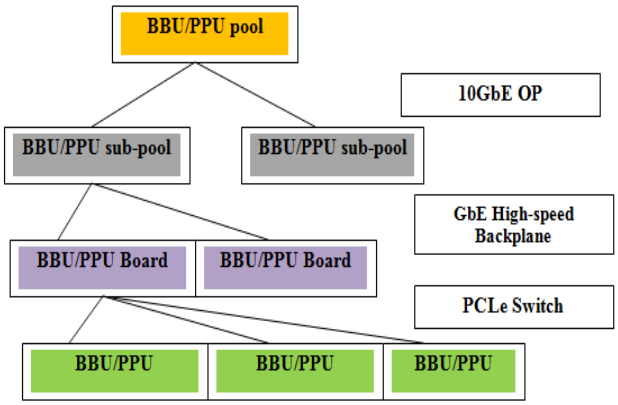


**Fig. 2:** Resource pooling framework in Evolved Node B

Extensive scale asset pool synchronization: In versatile correspondence frameworks, it is essential to keep the synchronization among Evolved Node B. The Evolved Node B in conventional frameworks can accomplish both recurrence and time synchronization and guarantee the long haul strength of their clock frequencies by synchronizing their individual neighborhood tickers to GPS signals. Be that as it may, the GPS-based synchronization strategy has a few issues, for example, the GPS radio wire has particular requirements on establishment condition, a high disappointment rate and it can't bolster remote support. New advancements have been proposed to build a definitely synchronized system, for example, the IEEE 1588 Precision Time Protocol (PTP) [9], which give check synchronization in a fast neighborhood, and the one heartbeat for every second (PPS) and time of day (ToD) time interface for accuracy time synchronization [10].
In spite of the fact that the synchronization among all Evolved Node B in conventional systems isn't anything but difficult to accomplish, it winds up noticeably straightforward in the Evolved Node B framework, since all the VBSs are co-found and one single planning source can be utilized for all equipment units. In this paper, we propose a two-layer synchronization mechan-ism for the Evolved Node B, where all the equipment units in the framework get a similar clock flag input. In the primary layer, a concentrated clock circulate unit (CDU) is first synchronized to the GPS. At that point the CDU produces a 1 PPS synchronous reference flag, i.e., the present framework outline number, ToD, and exchanges the flag to all the equipment units in the asset pool. In the second layer, there is a clock specialist on every equipment, i.e., the BBU or PPU. Once accepting the synchronous reference motion from the CDU, the clock specialist will initially compute the circuit level transmission delay from the CDU to its lord equipment. In view of the synchronous reference flag got and the transmission postpone pay, all the equipment units in the asset pools are synchronized to the CDU.

### 3.2 Real-Time Virtualization

The substantial scale BBU and PPU pools with fast and low-idleness interconnections empower the worldwide asset sharing

among different VBSs in the Evolved Node B, which could be acknowledged by virtualization advances. With virtualization, a trans-parent deliberation of the equipment assets is given and changed into at least one sensible forms that can be utilized by various VBSs, while the administrations gave to the end clients are the very same path as customary Evolved Node B [11,12]. The issue is the way to acknowledge constant virtualization. Note that in the C-RAN and WNC, the asset virtualization is acknowledged through conventional IT-based techniques, for example, Xen and Vmware [12]. In these frameworks, the product and equipment assets are decoupled and shared in light of the working framework. A working framework reflection layer is made to deal with the preparing demands from various VBSs. Nonetheless, the making or changing errands from various VBSs will cause high framework operational cost and additional handling inactivity [12], where the basic information preparing inertness necessity in remote correspondence is difficult to be ensured [4].

The constant virtualization issue can be handled in the DSP-based Evolved Node B framework by a procedure level virtualization conspire, where the working framework deliberation layer is excluded. Fig. 3 demonstrates the four-layer ongoing virtualization structure for the Evolved Node B: equipment asset layer, virtual asset layer, virtual Base Station layer and virtual system application layer from base up. Every one of these layers are controlled by the GRMC straightforwardly without the include ment of working framework deliberation layer.

In the equipment asset layer, distinctive sorts of hard-product gadgets are decoupled and there is an equipment asset deliberation element over every gadget, which is utilized to deal with the comparing gadget. The handling abilities from various gadgets are then separated into littler pieces, for example, multi-strings for various physical layer strategies, and a bound together operational interface is given by the equipment asset reflection substance. Dissimilar to the customary IT-based virtualization, a procedure level virtualization is executed in the equipment asset layer, where various types of equipment assets can be planned straightforwardly without the intrusion of working framework. Along these lines the asset misfortune and framework musical show tional delay amid the booking of equipment assets are limited.

In the virtual asset layer, the equipment assets are amassed and shape the virtual asset pools, i.e., the BBU pool, PPU pool. The asset mapping between the virtual asset pool and equipment assets is kept up in this layer. It additionally gives a brought together operational interface to higher layers. In the VBS layer, the VBS administration element will allot reception apparatuses, BBUs and PPUs, gave by the virtual asset layer to various sorts of VBSs, as per the administration and operational necessity from upper layers. The VBS layer gives a programmable and reconfigurable interface to the virtual system administrators, for example, the virtual GSM, 3G and LTE organize administrators, who can be effortlessly developed and give distinctive system administrations in view of the prerequisite of end clients. Under this 4-layer virtualization structure, the system administrators never again need to concentrate on the equipment assets, however just on the best way to utilize the virtual assets gave by the VBS layer. In the lower layers, the equipment assets can be utilized and shared by all VBSs, in this way the asset use is significantly progressed.

Consistent online asset relocation: so as to enhance the framework asset usage, the preparing requirements from various VBSs are progressively planned to various equipment assets in the Evolved Node B, through online asset movement. For instance, when framework activity stack is low, the handling necessities from various VBSs can be mapped to a similar equipment asset; when a portion of the equipment asset is in a high use status, some portion of the preparing prerequisites can be exchanged to the equipment gadgets with a low use status. Along these lines, the equipment assets can be completely used. Besides, when a portion of the equipment gadgets come up short, the handling methodology can be exchanged to different gadgets immediately, consequently the framework unwavering quality is ensured.

In the super BS, a consistent online asset movement plot is proposed in view of the radio system controller (RNC) migration methodology in versatile correspondence net-works and the conventional virtual machine relocation in PC systems. The principle thought is to sensibly isolate the handling assignment and information setting amid the asset movement process. The handling errand is the physical layer or higher layer methodology, e.g., the turbo encoding/deciphering process. The information setting is the comparing registering data amid the systems, i.e., the memory, information structure, and status machine data. As appeared in Fig. 4, when GRMC starts an asset migration operation for the BBU or PPU handling errand (a), the BBU or PPU preparing assignment (an) utilizing equipment asset 1 is right off the bat suspended and the information setting is exchanged to equipment asset 2. At that point a comparing BBU or PPU handling undertaking (an) is re-based on equipment asset 2. The virtual asset layer refreshes the asset mapping for the virtual asset 1 and ties it to equipment asset 2. The additional information setting that is produced by equipment asset

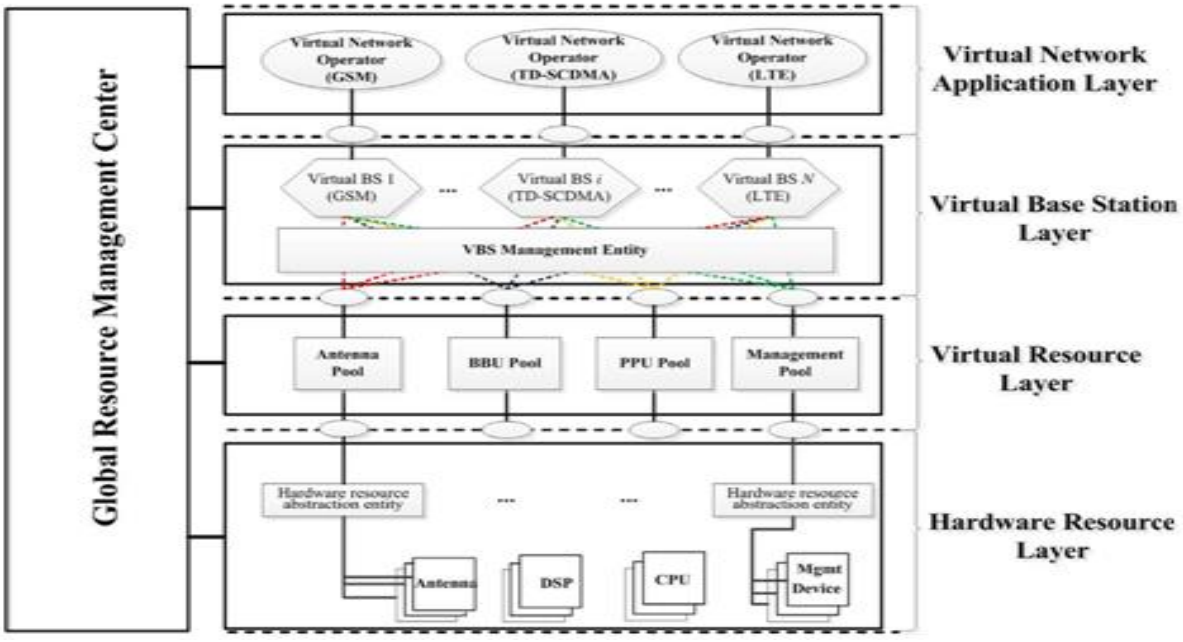


**Fig. 3:** The real-time virtualization framework for the Evolved Node B

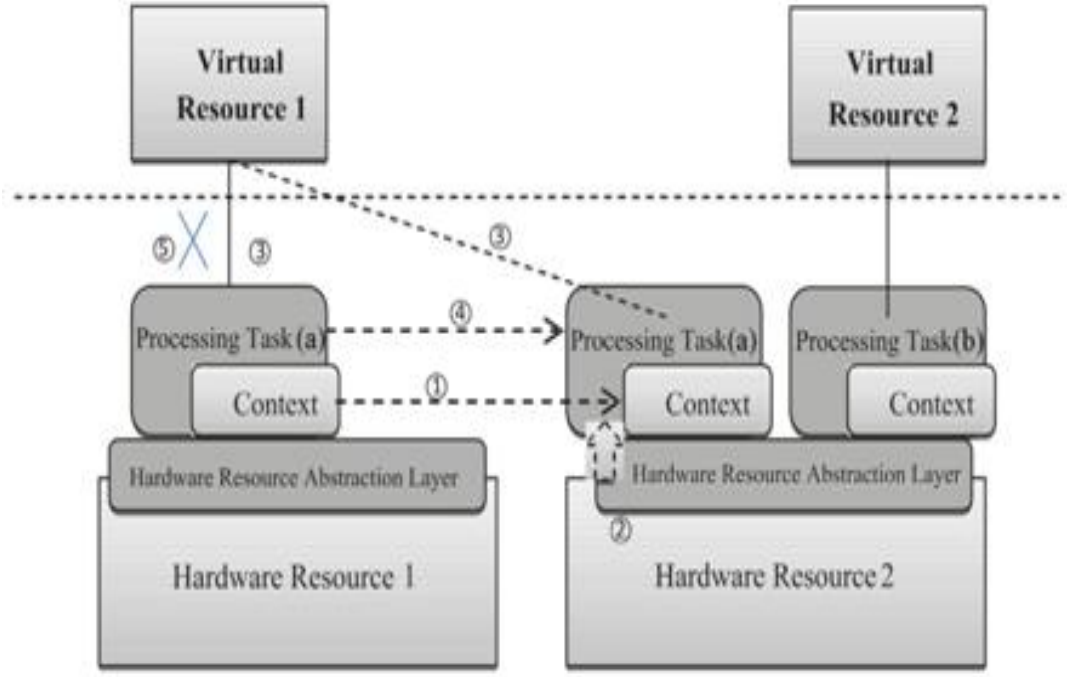


**Fig. 4:** Seamless online resource migration in the Evolved Node B

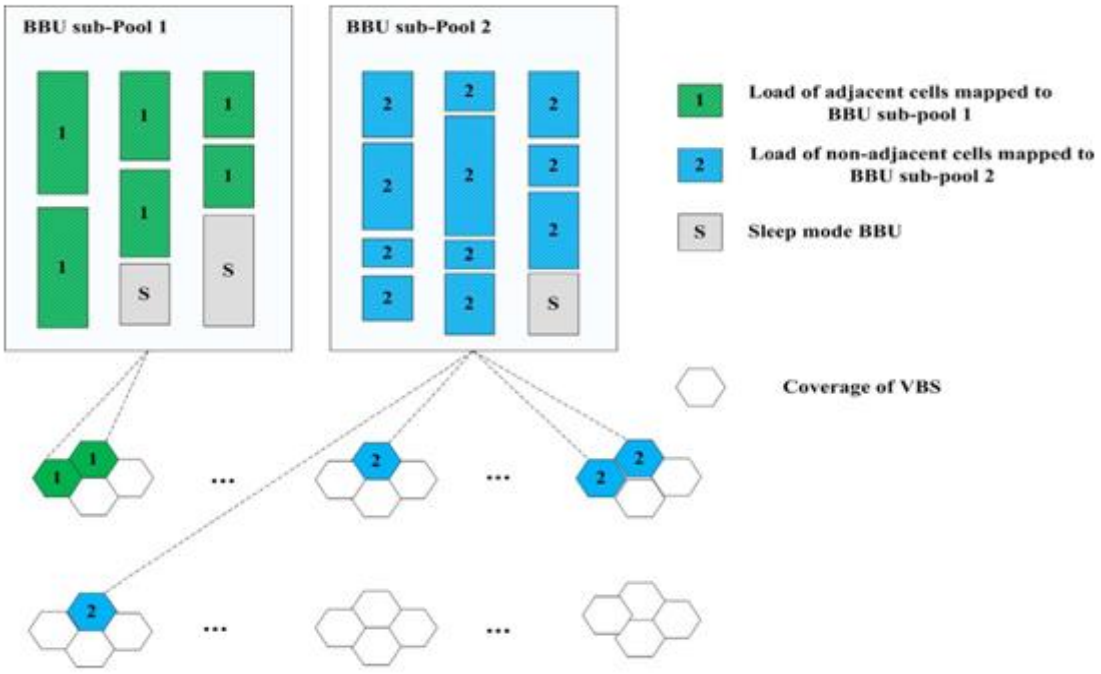


**Fig. 5:** Different hardware resource mapping schemes in the Evolved Node B

1 amid the asset relocation methodology is further transferred to equipment asset 2 to guarantee the consistent information exchange and the right request of the information data. From that point forward, the BBU or PPU handling assignment (an) is ended and all the comparing assets are pulled back by equipment asset 1. At last, the new BBU or PPU processing undertaking (an) is re-constructed and the asset relocation procedure for the virtual asset 1 finishes.

### 3.3 Versatile Equipment Asset Portion on Request

As the activity stack for various cells changes enormously after some time [4], when a VBS is in a high movement stack, more equipment assets are required. At the point when the activity stack is low, the excess equipment assets could be powerfully re-relegated to different VBSs with a higher movement stack.

Through versatile equipment asset portion, the system movement tide impact [4] can be successfully illuminated and the equipment asset usage can be expanded. Also, a portion of the equipment assets can be killed when the framework is in a low activity load to spare power.

Load assorted variety-based equipment asset designation: The principle objective of the equipment asset assignment is to maximize the equipment asset usage by finding an ideal mapping between the BBU/PPU pool and the VBSs, as indicated by the elements of framework movement stack. Theoretically, the ideal asset allotment can be acquired by consecutively planning the equipment assets to each VBS, until all VBSs preparing prerequisites are fulfilled. At the point when the framework movement stacks circulation changes, the equipment asset mapping between the BBU/PPU pool and the VBSs is changed as needs be, with the goal that the system activity tide-impact is

adjusted and the equipment asset use is boosted. In any case, the framework equipment mapping for all the VBSs should be balanced at whatever point the activity stack dispersion changes by utilizing this ideal arrangement. In framework usage, when the equipment asset for a given VBS shifts from one BBU/PPU to another BBU/PPU, all preparing assignments should be suspended and the correspondence setting should be exchanged. Accordingly a high framework computational overhead will be caused by visit asset designation alteration, particularly in an extensive scale framework.

To completely abuse movement stack assorted variety and stay away from the incessant worldwide framework asset alteration, a semi-static asset portion plot with stack decent variety (LDA) [13] is proposed. Note that, if the VBSs covering nearby cells are mapped to the same BBU/PPU sub-pool, it is very conceivable that the asset usage for the comparing BBU/PPU sub-pool will be at the same time either high or low. This is on the grounds that the system heaps of adjoining cells for the most part have a comparative time-geometry design. Accordingly a lot of equipment assets are required to deal with the pinnacle hour activity stack, while the equipment asset use will be very low when the movement stack for those adjoining cells goes down. In this manner, the primary thought of the LDA plot is to outline VBSs covering far off cells to the same BBU/PPU sub-pool. As appeared in Fig. 5, a proper arrangement of VBSs with inverse movement stack conveyance is first mapped to the same BBU/PPU sub-pool. At the point when the movement loads for the VBSs change, the asset designation for the VBSs that are mapped to the same BBU/PPU sub-pool is balanced with a higher need. On the off chance that the rest of the equipment assets on that specific BBU/PPU sub-pool can't fulfill the necessity of its serving VBSs, new BBU/PPU subpools are then doled out and the VBSs with a high movement stack are moved to the new BBU/PPU subpool. Inside a given BBU/PPU sub-pool, the asset mapping between the BBUs/PPUs and the VBSs can be changed over to a canister pressing issue, which can be settled by heuristic calculations, for example, the mimicked toughening and first fit calculations.

Fig. 6 analyzes the framework control utilization in the BBU pool of the proposed LDA plot with that of the static asset distribution in customary cell systems and the ideal arrangement depicted above, under a little size Evolved Node B framework with 50 cells amid a workday. Half of the cells speak to business regions while half of the cells speak to neighborhoods, the movement profile for every cell is gathered in [4].

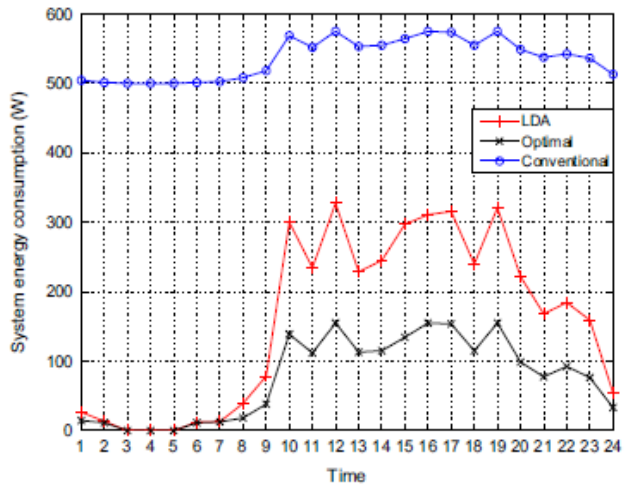


**Fig. 6:** System power consumption comparison under a small size Evolved Node B system with 50 cells during a workday

It can be seen that our proposed plot extensively diminishes the framework control utilization contrasted with the static asset allotment conspire in ordinary cell systems. The power utilization for the proposed LDA conspire is somewhat higher than the ideal asset allotment plot under the high framework movement stack situations. In any case, as the LDA plot maps the VBSs with inverse movement stack patterns to the same BBU sub-pool, the equipment asset can be balanced inside the BBU sub-pool. Along these lines the framework processing overhead caused by the asset movement between various BBU sub-pools can be diminished altogether.

## 4. Conclusion

There has been an agreement that the future 5G versatile framework will be a heterogeneous system, where various remote access innovations exist together and give high-transmission capacity administrations to end clients. In any case, an expanded system operational cost, high power utilization and low asset usage will be caused by the thick arrangement of multi-mode remote access focuses. The unified framework design is a promising answer for the above difficulties. In this paper, consistently dispersed however physically brought together new system engineering in light of the Evolved Node B is proposed. Distinctive sorts of framework assets are horizontally shared among all VBSs through the asset pooling strategies. To ensure the continuous preparing in correspondence arranges, a 4-layer constant virtualization system is presented. At last, an equipment asset allotment plot with stack assorted variety is introduced, where the equipment assets can be progressively assigned to various VBSs as indicated by their activity stack profiles. Little scale framework testing comes about have demonstrated that the power utilization in the BBU/PPU pool can be extraordinarily diminished and framework equipment asset use can be expanded under the Evolved Node B framework engineering.

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