

# Radio Packet Efficiency in Access Network

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**Abstract:** In view of increased penetration of Smartphone/M2M devices among users & high growth in data uses over mobile network, following document provides GSM radio resource allocation strategies & how we can achieve High GSM spectral efficiency. By modification in radio resource allocation strategies- form multislot assignment to single slot assignment in initial duration of packet data connection & by some modification in on-demand data resource allocation. After this we can observe reduction in total Number of PDCH requirement for the increased payload.

**Keywords:** Multislot, Packet Data Efficiency, PDCH (Packet Data Channels), OPDCH (On-Demand Packet Data Channels), TBFs (Temporary Block Flow).

## I. INTRODUCTION

Packet Data Efficiency in access network enable us to increase the efficiency of Packet Data Channels (PDCH's), using fewer radio resources for increased data volumes, with maintaining voice KPIs. PS data traffic in GSM is increasing exponentially in many networks due to growth of both Smartphone and M2M devices. Without the feature, this growth would require larger number of timeslots to be configured for PS, thus competing with voice capacity requirements.

Spectral efficiency improvements for GSM data will also be essential to facilitate future data growth. With Packet Data Efficiency we can control on-demand channels are fetched and returned to CS domain based on the usage of the existing channels.

In short, the main benefits are:

- Fewer PDCHs used to carry existing or increased data volumes; i.e improved PDCH Utilization
- Improved PS performance for busy/non-busy hour scenario since TBFs that fully utilize channels will trigger more fetch of ODPDCHs
- Increase of Smartphone/M2M devices that can be serviced and supported in the network
- Better handling of TBFs during their start-up & modification in on-demand data resource allocation can Show increase in GSM Packet Data Spectral efficiencies of 20-30%.

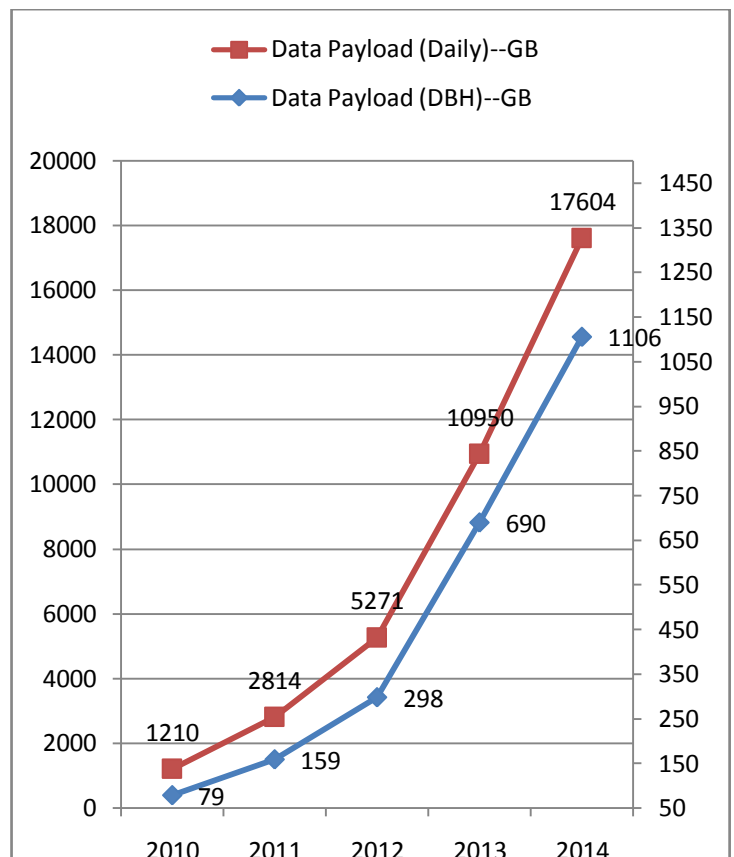
## II. FUNCTION DESCRIPTION

This new strategies of resource allocation introduces new algorithms that control the allocation, de-allocation, of On-Demand Packet Data Channels (ODPDCH's).

Traditionally, additional OD-PDCH's are allocated based on the average number of Temporary Block Flows (TBF's) stacked on each PDCH.

With this new feature,OD-PDCH's are instead allocated based on the average user traffic carried by the existing PDCH's.

Data Growth Curves 2010 to 2014 in one PLMN of India:-



Showing data Payload for 24 Hr. & Data busy Hours in last 4 years in Indian scenario.

This not only allows more efficient use of timeslot resources, where more data traffic can be carried using fewer PDCH's, but also is better suited to serve data users in a voice busy & non-busy hour scenario.

Allocation of additional PDCH's will no longer blindly consider a terminal's Multi-Slot class if carried traffic on the existing PDCH's is below the utilization threshold.

When de-allocation or pre-emption of a PDCH is triggered, the PDCH is selected such that fragmentation or splitting of the PSET is avoided. The aim is to keep the PDCH's grouped together to increase TBF efficiency.

A round robin method for allocation of signalling TBF's across all PDCH's is introduced. This protects traffic flows and provides signalling robustness compared to the legacy allocation on a single PDCH.

With this Feature activated in a cell the legacy of TBFLIMIT concept is replaced with the PDCH Use concept. Allocation of channels is based on the actual use of the PDCH's rather than the number of TBFs that are stacked on each other.

A number of strategies we can include for efficient allocation of resources:-

- One Slot TBF Reservation
- Distributed single block access
- Disabled MS Multi-Slot Class Triggers
- Revised PDCH Pre-emption
- Restricted Dual Carrier Allocation
- Applicable parts from M-239 Active TBF-limit
- Multiband support in cell.

The PDCH Use in each cell is measured based on how many non-dummy- and non-pre-emptive scheduled data blocks out of the total number of possible scheduled data blocks that are transmitted in the cell. This gives an accurate estimation of the PDCH use in the cell.

Packet Data Efficiency replaces the concept of letting the number of TBFs on a PDCH steer if the system should request more channels. Instead the feature looks on how the existing channels are used. If they serve data or signaling to a higher degree, then more channels are needed. Otherwise PDCH's could be released to the CSD Packet Data Efficiency regards the following data and signaling blocks as useful and counts this towards the scheduling percentage:

- Payload
- Retransmissions of lost payload
- Acknowledgements
- Keep alive signaling

The following are not counted towards scheduling percentage:

- Pre-emptive retransmissions
- Dummy blocks

An upper and lower PDCH Use threshold steer the number of OD-PDCH's in a cell. If the PDCH use in a cell is going under the lower threshold, one OD-PDCH is released. The PDCH to release is selected using the pre-emption algorithm with the condition of protecting only PDCH's used for DTM. If the PDCH use in a cell is going over the upper threshold, one more OD-PDCH is allocated. This is a continuous ongoing process.

Before requesting a channel, a check will be made which is the most capable channel type that is currently not allocated. A channel of that type is then requested. If the most capable PDCH is a B- or G-PDCH then it is requested only if there is traffic of that type in the cell. A

penalty for PDCH release will be applied, so that a certain time (default 3 s) will elapse since last channel release or channel allocation before next PDCH release.

### III. ONE-SLOT TBF RESERVATION

With 'One-slot TBF reservation' some users will get 1 + 1 reservation (1 PDCH UL, 1 PDCH DL). This is mainly targeted at bursty applications such as Chat/IM, Push Notifications, etc where the MSs will be allocated 1 + 1 to save addressing space and PDCH capacity. To achieve this all MSs will initially be assigned 1+1 until the buffer level exceeds a configurable threshold. If this threshold is passed the allocation will be according to Multi-Slot Class and available PDCH's.

With 'Service Based Radio Resource Management' (SBRRM) activated all users detected as low priority users and users with unknown priority shall be subject to the initial 1+1 allocation. As soon as the service class is identified only low priority users will remain in 1+1.

An MS not fulfilling its Multi-Slot class may no longer trigger request for more ODPDCH's to the cell. It's the average usage of PDCH's in the cell that shall decide when to allocate channels, not by individual request from an MS that isn't currently assigned its maximum amount of channels.

A check is still made on the sum of the mobile's Multi-Slot classes, in order to avoid allocating more channels that can be used by the current mobile population in the cell.

### IV. DISTRIBUTED SINGLE BLOCK ACCESS

The first signalling block at UL TBF 2-phase access is placed on TN6 in the design base. TN6 is also the most popular TS for packet transfers and it would be beneficial to move the UL at 2-phase access away from TN6. The UL shall instead be allocated in a round robin fashion on all available PDCH's that may be used for assignments (BCCD=YES or non-hopping frequencies). The TS that is most likely to be removed by the PDCH Usage function or pre-emption shall be avoided.

### V. DISABLED MS MULTI-SLOT CLASS TRIGGERS

An MS not fulfilling its Multi-Slot class may no longer trigger request for more ODPDCH's to the cell. It's the average usage of PDCH's in the cell that shall decide when to allocate channels, not by individual request from an MS that isn't currently assigned its maximum amount of channels. A check is still made on the sum of the mobile's Multi-Slot classes, in order to avoid allocating more channels that can be used by the current mobile population in the cell.

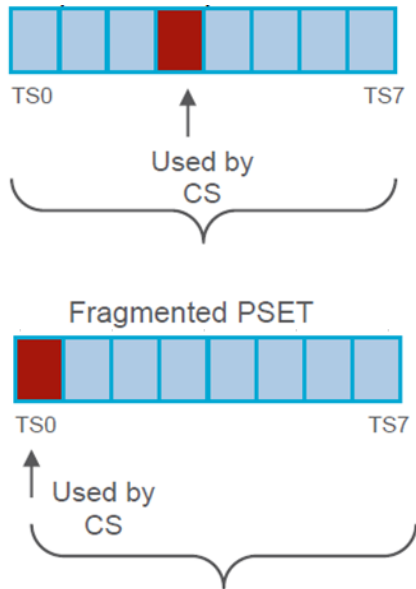
### VI. REVISED PDCH PRE-EMPTION

The design base behavior of when the RP evaluates which TS to preempt often causes fragmentation of the PSETs. Fragmented PSETs is a direct hit on utilization and should be avoided. The alternate preemption algorithm shall strive to keep the PDCH's grouped together so they will be possible to share by as many TBFs as possible.

**VII. RESTRICTED DUAL CARRIER ALLOCATION**

A mobile in a downlink dual carrier transfer may be scheduled on the UL on either of the carriers, but only on one at a time. This means that that the TBF will occupy addressing resources on both carriers. The change when this feature is activated is that the UL TBF will only be reserved on one carrier and thereby reduce the use of addressing space.

A TBF will only be put in Dual Carrier mode if it's downlink biased with this feature activated.



PSET kept intact!

Fragmented PSET PSET kept intact!

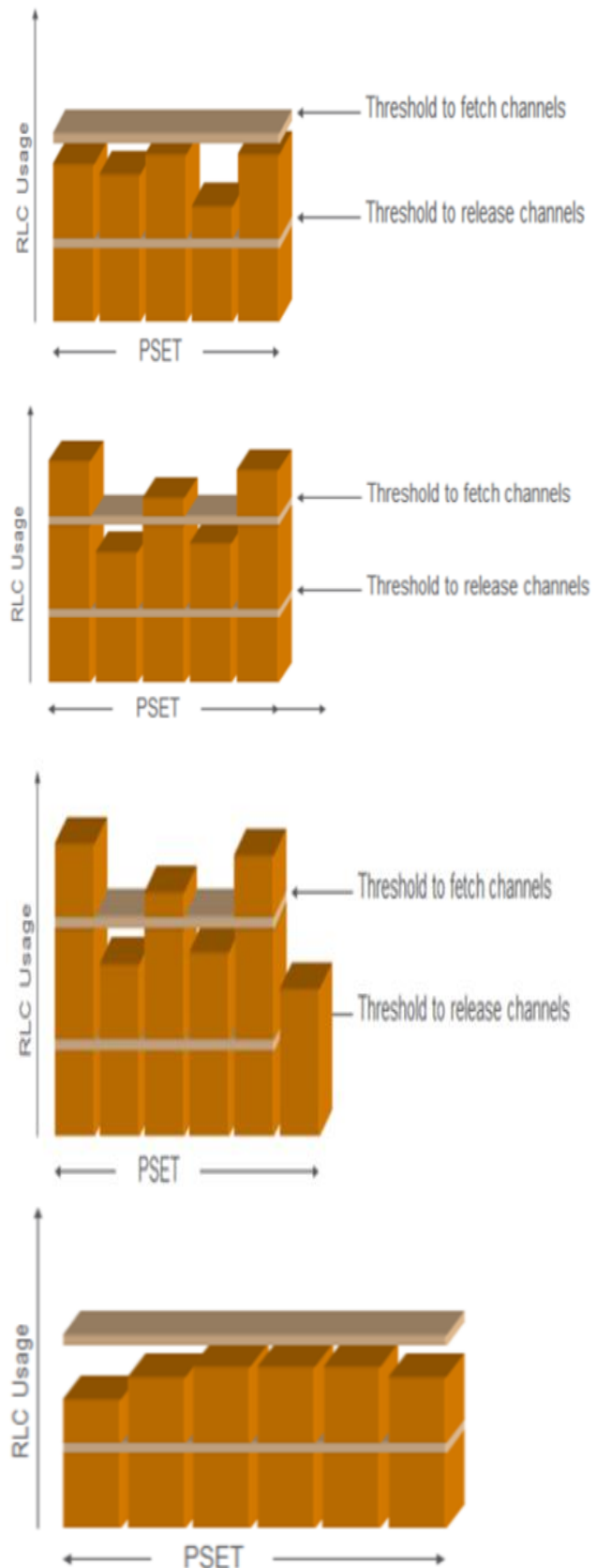
**VIII. MULTIBAND SUPPORT IN CELL**

The purpose of the multiband support is to protect preemption of PDCH's when there are one or more MSs allocated on the channel that have limited baseband capability. This functionality is only used when EPU is active. For best result, it is highly recommended to set the parameter PDCHPREEMPT to less or equal to 1. It is recommended to not use QoS class Streaming when this feature is activated. Intra cell handovers may increase and there is a potential TBF drop rate increase.

**IX. PARAMETER CONTROL**

The functionality of the feature is controlled on cell level by four new cell parameters listed below:

- Status of PDCH allocation based on PDCH Use (on/off)
- PDCH Use upper threshold (20-90 %)
- PDCH Use lower threshold (10-80 %)
- One-slot TBF Reservation threshold (0 – 500 bytes)



All four parameters will be combined into the one 16 bit bitmap.

- PDCH allocation based on PDCH Use.
- Upper threshold is 60 % (6)
- Lower threshold is 40 % (4)
- One-slot TBF Reservation is triggered below 200 bytes

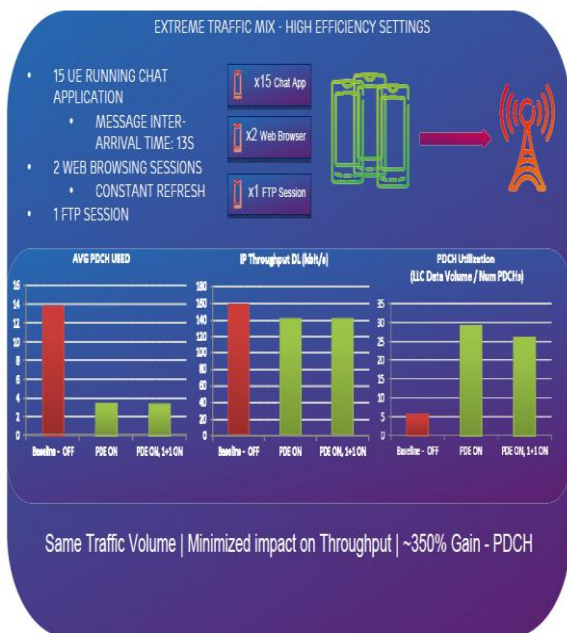
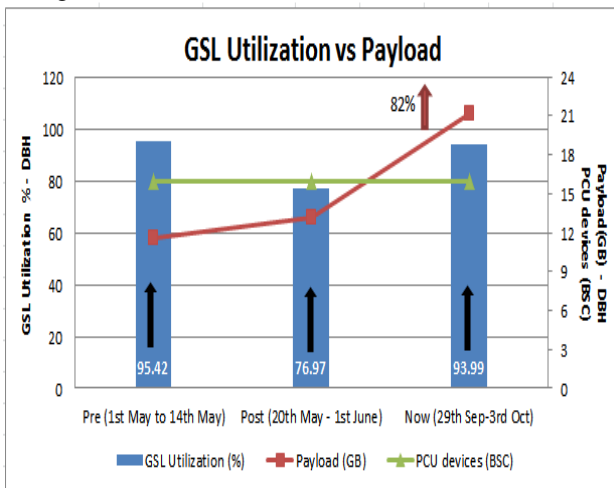
### X. IMPACT

The following KPI areas might be affected:

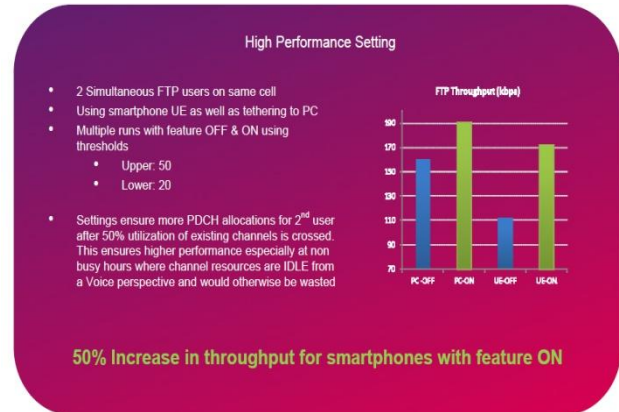
- Intra cell handovers due to TCH optimization may increase .
- Number of preempted TBFs may increase
- PDCH utilization will increase. Absolute PDCH will decrease
- IP Throughput KPI might decrease in some cells.

### XI. TRIAL RESULTS

Below is the Lab result of this feature trial with different setting



Same Traffic Volume | Minimized impact on Throughput | Session



### XII. OPERATOR VALUE

Total Cost of Ownership More efficient utilization of installed TRX capacity can be attained. With PS traffic Growth, need for TRX and PCU expansions are reduced. Improved end-user experience; happier Users leads to reduced churn Increased Revenues Increased carried data traffic by up to 100%, and thus revenue, is achieved by the improved efficiency of On-Demand Packet Data Channels Performance Setting 50% Increase in throughput for smartphones with feature ON

- 2 Simultaneous FTP users on same cell
- Using smartphone UE as well as tethering to PC
- Multiple runs with feature OFF & ON using Voice perspective an

### XIII. CONCLUSION

By changes in the radio allocation strategies we can deal with the booming growth of data uses in the same GSM network. It's can be a most cost effective solution for the operators as well for their customers for their moderated data requirement .Penetration of GSM is very deep with respective 3G & 4G in India like country so this can be the fastest way to provide the best & better data services to maximum users instantly.

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