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DC-HSDPA ROLLOUT STRATEGIES

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Considering the rapid development of data traffic, it is very important to continuously monitor the needs for upgrading the existing solutions and introducing technologies to maintain CAPEX and OPEX optimally. In this paper deployment of DC-HSDPA is introduced and some strategies for rollout are mentioned.

Keywords: HSPA, 64QAM, DC-HSDPA, rollout, strategy.

Introduction. Network quality is the basis of competition among operators as in line with a number of research reports, subscribers have started to pay increasingly more attention to quality, especially when it comes to the currently booming data traffic. With the increasing complexity of the offered services and the evolution of new technologies, the focal point of operators has changed from technology to subscriber experience.

Current solutions allowing gradual convergence of all traffic classes to full IP handling, or efficient intersystem balancing mechanisms open many possibilities of network cooperation strategy. In this scope, spectrum management is investigated based on the utilization and the resulting performance, accordingly potential modification or further refarming activities are considered and proposed if applicable. Spectrum refarming allows to maintain effective frequency utilization with the developing technology and service needs. In particular, LTE radio technology is the most spectrally efficient, hence it is expected that with growing technology maturity and full IP confidence, at some point, frequency spectrums of operators may be fully taken over by LTE.

DC-HSDPA utilizes two adjacent WCDMA carriers to transmit two parallel HSDPA streams to the single UE. DC-HSDPA operation improves the end-user performance by pooling the radio resources of two carriers simultaneously for the same user. Hence, with 64QAM feature, the DC-HSDPA expands the DL bit rate up to 42 Mbps (2 x 21 Mbps), while with basic 16QAM capability-up to 28 Mbps (2 x 14 Mbps). Moreover, by using a joint-scheduler configuration, it takes advantage of the statistical multiplexing, multi-user diversity and frequency selectivity in order to achieve improved spectral efficiency. Therefore, with DC-HSDPA not only the end

user throughput is improved, but also the overall site capacity, as observed in a number of commercial deployments [1-3].

The RNC (Radio Network Controller) decides upon the DC-HSDPA RAB (Radio Access Bearer) establishment based on the IE (Information Element) (multi-cell capability: true) provided in the UL RRC (Radio Resource Control): RRC Connection Request and the support of the NodeB. However, for instance, when one of the DC-HSDPA cells is congested or radio conditions are low, the RNC can decide to configure the regular HSPA RAB, even if both the UE and the NodeB have DC-HSDPA capabilities.

The UL transmission is handled by the HSUPA channels, but to only one cell, which is called the Primary DC-HSDPA cell. Also, the UL HSDPA feedback, i.e. HS-DCCH (CQI and ACK/NACK) is delivered only to the Primary cell. The other cell (can be even not HSUPA-capable) is called Secondary DC-HSDPA cell and handles only the DL transmission. Considering the HSUPA capability in the DC-HSDPA cells, the two configurations are differentiated: (i) Fixed DC-HSDPA configuration – only one cell is HSUPA-enabled (Primary cell), and (ii) Flexible DC-HSDPA configuration – both cells are HSUPA-enabled. With the Flexible DC-HSDPA configuration, the RNC evaluates which cell has been reported with the better condition and then decides to allocate it as Primary Cell in the DC-HSDPA RAB Configuration/Reconfiguration message to the UE. Also, during the ongoing DC-HSDPA connection, the Primary/Secondary cell assignment can be seamlessly reconfigured. Practically, networks are loaded by HSPA traffic hence operators do not have the motivation to sacrifice any of the layers for disabling HSUPA. Therefore, most commonly, the Flexible DC-HSDPA configuration is applied.

The complete physical channel structure is presented in Fig.1. Precisely, the Primary cell handles all UL channels including HSUPA (E-DPDCH, E-DPCCH), HSDPA feedback (HS-DPCCH), and R99 SRB (DPDCH, DPCCH), or only DPCCH if SRB is mapped on the HSPA channel (optionally).

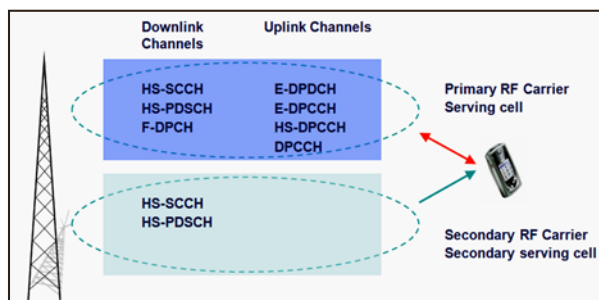


Fig. 1. Involved physical channels in DC-HSDPA

In the DL, each DC-HSDPA cell transmits independently 1-15 HS-PDSCH channels and 1-4 HS-SCCH channels. Additionally, the Primary cell handles the SRB, which in DL goes either conventionally via R99 channels then DPDCH and DPCCH are transmitted or optionally via HSPA channels, then F-DPCH is used in the DL to deliver the TPC bits to the Ues.

The cell-independent scheduling requires cell-independent AMC (Adaptive Modulation and Coding) and cell-independent H-ARQ (Hybrid-Automatic Request) processes. In order to facilitate these requirements, the HS-DPCCH UL feedback channel has been modified to include both CQIs and H-ARQ information for each layer separately. This has been achieved by reducing the redundancy ratio of the HS-DPCCH, thus providing more capacity for the information bits. In order to guarantee the same HS-DPCCH reception quality, the repetition period has been incremented.

DC-HSDPA is maintained during SCC (Serving Cell Change) for both inter- and inter- NodeB as long as the target cell supports the DC-HSDPA and the AC (Admission Control) decides accordingly. On the contrary, the IFHO (Inter Frequency Handover) between two DC-HSDPA pairs is not supported, i.e., a switch to HSPA is required if HSDPA CM (Compressed Mode) is supported, otherwise downgrade to R99 is performed. However, this should be noted that DC-HSDPA IFHO procedure is a very uncommon scenario, as this would require an operator to have 4 HSPA layers deployment with two separate DC-HSDPA pairs.

The DC-HSDPA evolution introduces DB-HSDPA (Dual Band-HSDPA), for which the RF carriers can be in different operating bands (e.g., 900 and 2100). This is certainly a very attractive feature for operators with carriers spread across bands, and significantly increases their flexibility in DC-HSDPA implementation. The number and supported combination of frequency bands is limited as provided in Table 1, Table 2.

Generally, the concept and the functionality of DB-HSDPA are the same as those enabling DC-HSDPA 42 Mbps to peak data rate. Additionally, switches between the DB-HSDPA and DC-HSDPA are possible if the scenario is applicable. MIMO is not supported together with DC-HSDPA at the same time.

Enabling of DC HSDPA in the network required feature interdependencies (Table 3) [4]:

- Available features provide the following limits (Fig.2):

- ☐ Max number of HSDPA users per cell: 72
- ☐ Max number of HSUPA users per cell: 72
- ☐ Max number of HSUPA users per LCG: 80

- As each DC-HSDPA user requires a HSUPA return channel, the number of DC-HSDPA is limited by a maximum number of HSUPA users allowed.

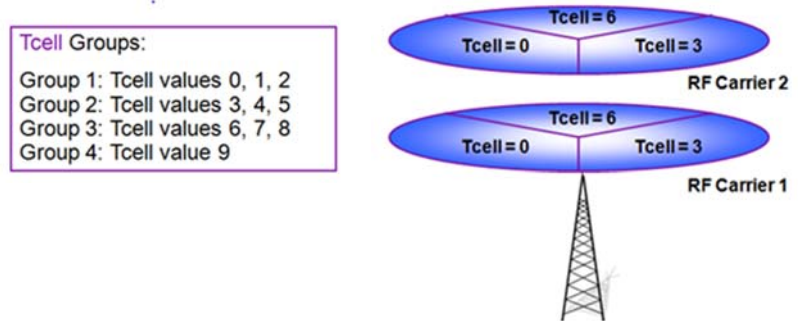


Fig. 2. DC-HSDPA configuration

Each cell belonging to the same sector must have the same Tcell and each cell belonging to the same layer must have Tcell value from a different group.

Table 1

DB-HSDPA (42 MBPS) OPERATING BANDS

Operating Band	UL Frequencies UE transmit, Node B receive	DL Frequencies UE receive, Node B transmit
I	1920...1980 MHz	2110...2170 MHz
II	1850...1910 MHz	1930...1990 MHz
III	1710...1785 MHz	1805...1880 MHz
IV	1710...1755 MHz	2110...2155 MHz
V	824...849 MHz	869...894 MHz
VI	830...840 MHz	875...885 MHz
VII	2500...2570 MHz	2620...2690 MHz
VIII	880...915 MHz	925...960 MHz
IX	1749.9...1784.9 MHz	1844.9...1879.9 MHz

Table 2

DB-DC-HSDPA Configuration	Uplink Band	Downlink Band
1	I or VIII	I and VIII
2	II or IV	II and IV
3	I or V	I and V

Table 3

<ul style="list-style-type: none"> ▪ HSDPA 64QAM ▪ Based on 3GPP 25.321 ▪ Optional Feature ▪ RNC License Key required (ON-OFF) ▪ UE categories 13, 14, 16 and 17 supported. ▪ Prerequisites: <ul style="list-style-type: none"> ▪ Flexible RLC ▪ HSDPA 14.4 Mbps ▪ HSDPA 16QAM ▪ Dynamic Res. Allocation ▪ HSUPA ▪ 	<ul style="list-style-type: none"> ▪ HSDPA DC-HSDPA ▪ Based on 3GPP 25.321 ▪ Optional Feature ▪ RNC License Key required (ON-OFF) ▪ UE categories 21, 22, 23 and 24 supported. ▪ Prerequisites: <ul style="list-style-type: none"> ▪ Flexible RLC ▪ HSDPA 14.4 Mbps ▪ HSDPA 16QAM ▪ Dynamic Res. Allocation ▪ HSUPA ▪ HSDPA 64QAM (for 42 Mbps) ▪ Shared Scheduler
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DC-HSDPA implementation strategies:

DC-HSDPA requires HSDPA to be enabled at least on two carriers in one cell, and at least one of them is required to have enabled HSUPA. This leads to the following site level implementation options:

- 2 carrier dedicated 3G data network, voice moved to GSM
- 2 carrier 3G network, carriers shared with R99 traffic and HSDPA/DC-HSDPA
- 3 or more carrier 3G network with 2 carriers dedicated for HSDPA/DC-HSDPA, rest dedicated for R99 or shared
- Dual band network with two carriers in one band with DC-HSDPA

DC-HSDPA roll-out strategies:

Following feature roll-out options:

- Enabled DC-HSDPA in only traffic hotspots
- Enabled DC-HSDPA in high traffic areas such as city centers
- Network wide rollout.

Multicarrier layering strategies:

The layering strategy defines the mechanism to move Ues to the correct layer(s):

- Idle mode UE camping
- Transitions between the layers
- Load, service, and capability-based handovers
- Handling carrier edges if all carriers are not implemented network.

Operators can use different strategies for DC-HSDPA deployment:

Strategy (1)

Two carrier HSDPA network, realtime traffic (mainly voice) moved to GSM

- In multisystem network with network wide support for GSM, CS voice calls can be moved to GSM network. Voice quality is similar in 3G and GSM systems. After voice call is completed, the UE returns to 3G network with idle mode cell reselection.

- This would release more capacity for data users (R99 NRT, HSDPA, DC-HSDPA)

- 3G network would in practice be for data only, assuming number of CS voice multi-RAB and video calls is small

- R99 data calls could also be moved to GSM, but that would affect the end user experience since 3G R99 data speeds and latencies are better than GSM even with EDGE

- Capacity upgrades might be required in GSM network to accommodate the voice traffic coming from 3G network

Strategy (2)

Two carrier HSDPA network, carriers are shared with realtime traffic:

- HSDPA need to be enabled in both carriers to use DC-HSDPA, and resources are shared with R99 voice and data traffic

- Some resources are used for R99 services, which slightly affect HSDPA and DC-HSDPA performance

- All 3G users are retained in 3G network, no impact to GSM

Strategy (3)

Three or more 3G carriers, one carrier is dedicated for R99 traffic and others for HSDPA / DC-HSDPA traffic

- One dedicated carrier for R99 services

- Two or more dedicated carriers for HSDPA / DC-HSDPA

- HSDPA / DC-HSDPA load will not impact the R99 carrier

- The layering strategy needs to be planned

Conclusion:

1. Generally, DC-HSDPA is a next capacity upgrade step after the HSDPA 64QAM activation.

2. Significant CAPEX with DC-HSDPA activation (CE needs/schedulers). However, additional schedulers also help regular HSDPA users. Hence, CAPEX related to the overall traffic increase can be minimized (extra schedulers are already deployed).

3. The expected single user throughput is increased by 100% in low-loaded network

4. The network level capacity gain in loaded network can be more than 20% even in the cell edge

5. With more than 2 layers, the operator needs to guarantee proper DC-HSDPA availability (HO forcing scenarios).

6. The next capacity step would be multicarrier HSDPA or DC-HSDPA with MIMO.

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DC-HSDPA ՆԵՐԴՐՄԱՆ ՌԱԶՄԱՎԱՐՈՒԹՅՈՒՆԸ

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Հաշվի առնելով տվյալների տրաֆիկի արագ զարգացումը՝ կարևոր է շարունակաբար վերահսկել առկա լուծումների արդիականացման կարիքները և տեխնոլոգիաների ներդրումները՝ CAPEX-ը և OPEX-ը օպտիմալ ռեժիմում պահպանելու համար: Ներկայացվել է DC-HSDPA-ի ներդրումը և նշվել մի քանի ռազմավարություն՝ այն իրականացնելու համար:

Առանցքային բաներ. HSPA, 64QAM, DC-HSDPA, ներդրում, ռազմավարություն:

СТРАТЕГИИ ВНЕДРЕНИЯ DC-HSDPA

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С учетом быстрого развития трафика данных показана важность постоянного контроля потребностей в модернизации существующих решений и внедрении технологий по поддержанию CAPEX и OPEX в оптимальном режиме. Представлены внедрения DC-HSDPA и рассмотрены некоторые стратегии их осуществления.

Ключевые слова: HSPA, 64QAM, DC-HSDPA, внедрение, стратегия.