

# Title: 5G NR NSA Optimization Hints

## 1. 5G NSA implication to pre-existing LTE technology

In a Non-Standalone deployment, 5G network is built on top of existing LTE so that the 5G infrastructure relies on the LTE network (mostly coverage) for certain main functions, as signaling and initial connectivity, and for certain basic and optional features.

In general, and of course depending on the proper coverage and capacity planning, the integration of 5G with LTE in NSA deployments can lead to improvements in LTE performance for a few reasons:

- **Spectrum Efficiency:** 5G and LTE could share similar or different spectrum, as both technologies can coexist and benefit from the available bandwidth. Consequently such spectrum aggregation allows for more efficient use of all the available operator frequencies, thus resulting in better overall network performance.  
However the exact network topology, the network deployment (LTE & NR sectors coexistence or collocation) and the subsequent band combinations for coverage merging is crucial and ***it should be studied per case or per cluster.***
- **Enhanced Capacity:** 5G NSA, especially for the 5G NR sector in the FR1 sub6GHz bands with sub-carrier spacing 30 kHz, allows for increased network capacity. Moreover combining the LTE capacity with the 5G NR capacity, by aggregating LTE and 5G resources, can be utilized to handle more data traffic, leading to improved performance for LTE users, ***under the restriction of adequate user's 5G NSA capable handsets penetration in the market.***
- **Faster Data Rates:** The expected deployment and integration of 5G NR FR1 with LTE could lead, ***under proper coverage study analysis,*** to higher expected data rates for LTE users. As a result operators could potentially offer faster data rates to users who do still primarily use LTE ONLY devices by combining the capabilities of both technologies with proper capacity and coverage analysis. A potential enhancement would be achieved with the introduction of the technology of Dynamic Spectrum Sharing (DSS).

However in order to exploit the full LTE capacity benefits, a further capacity/coverage study should be conducted in coordination with the full functionality of the vendor's NSA solution (i.e. the 5G NSA DL and UL bearer aggregation, leg switching and potential combination of 5G NSA + CA).

- **Improved Latency:** On its primary functionality in FR1 SCS = 30 kHz, 5G NR is designed to deliver lower latency compared to LTE, thus improving the KPI traffic performance.

## 2. 5G NSA Proposed Deployment Scenarios

The LTE coverage should be first of all adequate in all involved carriers before adding the NR carrier for the NSA traffic performance.

Dynamic Spectrum Sharing is one of the most successful and popular features among operators, since it facilitates the fast and cheap 5G deployment on top of LTE pre-existing technology, bands and infrastructure [1].

Here are some reasons why Dynamic Spectrum Sharing is useful in 5G NSA deployment:

- **Smooth Transition:** DSS enables a smooth transition from 4G to 5G by allowing both technologies to coexist in the same frequency band. This means that operators can leverage their existing 4G infrastructure while gradually deploying and expanding their 5G networks.
- **Optimal Spectrum Utilization:** Spectrum is a valuable and limited resource. DSS allows for optimal utilization of available spectrum by dynamically allocating it between 4G and 5G based on demand. This flexibility ensures efficient use of the spectrum, maximizing network capacity and performance.
- **Cost-Efficiency:** Deploying a new network infrastructure can be expensive. DSS allows operators to reuse existing 4G infrastructure, such as antennas and radios, reducing the overall deployment costs associated with building a separate 5G infrastructure.
- **Faster 5G Rollout:** DSS enables a faster 5G rollout by leveraging existing 4G infrastructure. Operators can quickly deploy 5G services

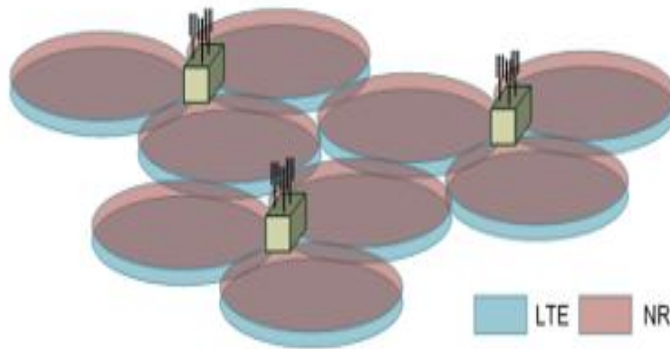
without the need for extensive new hardware installations, as DSS allows for a gradual transition and coexistence with 4G.

- **Spectrum Flexibility:** DSS provides operators with the flexibility to allocate spectrum dynamically based on real-time network conditions and user demand. This ensures that both 4G and 5G users receive optimal service quality and data speeds, enhancing the overall user experience.
- **Improved Spectrum Efficiency:** With DSS, operators can better manage and balance the load on the network, ensuring that spectrum resources are used efficiently. This is essential for providing reliable and high-performance connectivity, especially in densely populated areas.
- **Enhanced Network Performance:** DSS enables a more efficient use of spectrum, which can result in improved network performance for both 4G and 5G users. This includes faster data speeds, lower latency, and overall better quality of service.

Following a market analysis, the most dominant and mostly recommended 5G NSA deployment topologies by Ericsson, Huawei, Nokia, Samsung, ZTE etc are [2-5]:

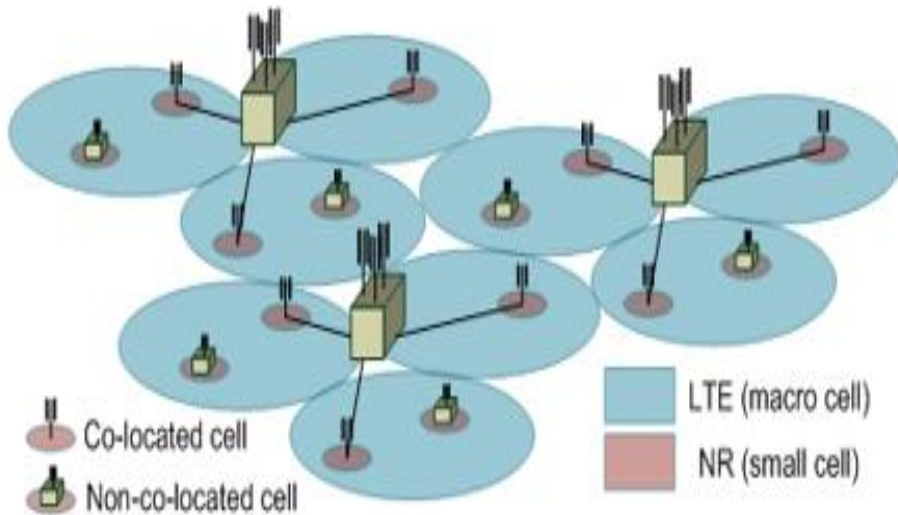
**2.1 Collocated Co-coverage Mode:** In this mode, both LTE Base Station (i.e. ng-eNB) and 5G NR Base Station (i.e. gNB) provide same coverage. This will happen when NR is operating in a similar band as LTE with a strongly proposed strategy for co-located cells. A Typical deployment scenario, ***highly recommended*** for the band combinations of:

- $f < 1$  GHz for LTE in 700/800 MHz and 5G NR in 450/600/700/800 MHz with Dynamic Spectrum Sharing
- $1 \text{ GHz} < f < 3 \text{ GHz}$  for typical LTE bands 1800/1900/2100/2600 and 5G NR 1800/1900/2100/2600
- $3 \text{ GHz} < f < 6 \text{ GHz}$  for both LTE and 5G NR in C-bands



**2.2 Collocated Heterogeneous coverage:** In this mode, both LTE and 5G NR base stations serve different coverage areas. In such a deployment scenario the proper technology having less coverage (higher band) will support higher capacity and vice versa. As a consequence LTE and 5G NR cells function either as small cell or as macro cell and vice versa. We can discriminate into two cases:

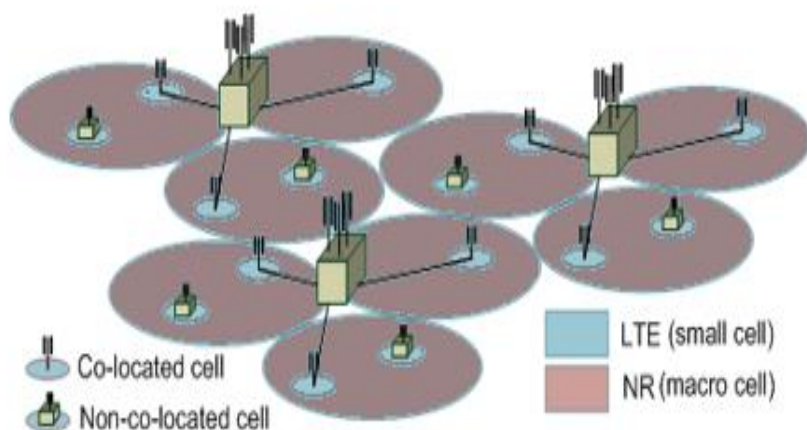
- **Case #1 – LTE high coverage footprint:** In this kind of deployment LTE cell covers a large area to meet coverage requirement (i.e. typical LTE bands on LTE 450/600/700/800 and 1800), perhaps on Dynamic Spectrum Sharing (DSS) deployment with 5G NR, while NR cell size and footprint is small to meet the higher capacity requirements (i.e. typical 5G NR bands on NR 2100/2600, NR C-Band 3.4-3.7 GHz or even better for enhanced capacity in mmW bands). In this scenario the NR cell is highly proposed to be deployed as collocated with LTE, although there could be also some 5G NR small island coverage cells (hot spots) mostly on mmW bands.



- **Case #2 – NR high coverage footprint:** In this kind of deployment NR cell is large cell size to meet coverage requirement while LTE cell size is small to meet the capacity requirements. Here the NR cell can be deployed as a co-located cell or a non-located cell as a hot spot.

**Important Notice:** This is not recommended, due to unwanted mobility SCG releases if LTE anchor handover fails.

Moreover the expected NSA SCG additions/releases would increase signaling flow, keeping the throughput lower than expected.



### 3. Proposed Optimization strategies

In a 5G Non-Standalone (NSA) deployment, where 5G is deployed on top of existing LTE (Long-Term Evolution) infrastructure, it's common and highly recommended for LTE coverage to be higher than the 5G New Radio (NR) coverage. There are several reasons for this:

- **A.** LTE networks have been deployed for a longer time and are more mature than 5G networks in many cases. As a result, LTE networks often have broader coverage and are more widely established.
- **B.** In a 5G NSA deployment, the LTE network serves as the anchor for signaling and initial connectivity. Since LTE infrastructure is already in place, it contributes to the coverage of the overall network. 5G NR SCG is then added to provide additional capacity and capabilities in specific areas closer to the antenna.
- **C.** The frequency bands allocated for LTE may differ from those allocated for 5G NR. In some cases, LTE may be using lower frequency bands that offer better coverage compared to the higher-frequency bands allocated for 5G NR.

Lower-frequency signals generally propagate over longer distances and penetrate obstacles more effectively, leading to broader coverage with outdoor to indoor better performance. Since LTE is always the anchor cell, it should always have longer coverage to support initial service accessibility.

- **D.** Many existing user devices are LTE-only or LTE-primary. In a 5G NSA deployment, these devices primarily rely on LTE connectivity. As 5G-capable devices become more widespread, the coverage area for 5G NR is likely to increase.
- **E.** LTE provides the foundation for connectivity, and 5G NR is introduced to enhance capacity and data rates. The collocation of LTE and 5G in NSA deployments allows for seamless handovers between the two technologies, ensuring continuous connectivity as users move through different coverage areas.

However in such scenarios there is one severe drawback which has to be systematically and analytically studied on parameters and features. This is the expected DL/UL imbalance in the case of higher 5G NSA frequency bands, i.e. 3500 MHz C-Band or mmW. 3GPP Release 15 introduces two mechanisms to handle the limited uplink coverage on the higher bands, namely NR Carrier Aggregation (CA) and supplementary uplink (SUL). The use of these mechanisms effectively utilize idle sub-3 GHz band resources, improve the uplink coverage of C-band, and enable the provisioning of 5G services in a wider area. By implementing both solutions, NR CA and SUL, operator could use extensively the DL/UL decoupling feature, offering transport of UL user data using sub-3GHz band over LTE or NR radio resources while keeping the DL in the 5G high capacity bands. NR CA provides the added benefit of also providing sub-3GHz DL user data support. Based on the SUL, the feature Uplink and Downlink Decoupling defines new paired spectrums, where C-band is used for the downlink and a sub-3 GHz band (for example, 1.8 GHz) for the uplink, thereby improving uplink coverage. Figure 10 shows how UL and DL Decoupling works [6].

Follows two common, popular and highly recommended 5G NSA optimization scenarios [7-8].

**3.1 Optimization scenario 1:** The preferred deployment scenario, which should be highly prioritized and promoted, would be the 5G NR collocation with the pre-existing LTE on the same tower and same coverage (similar or same bands).

There are many benefits from such deployment:

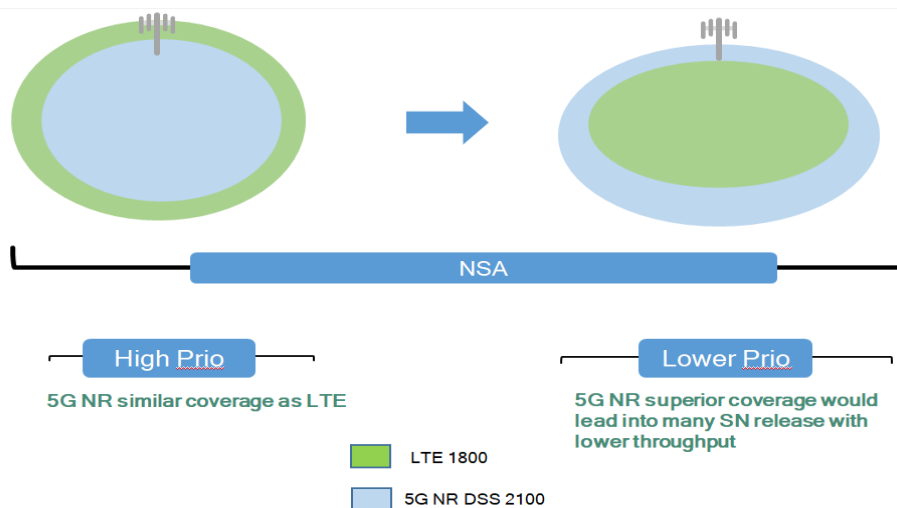
- In a collocated or coexisting deployment, 5G and LTE share the same or similar frequency bands. This allows for more efficient utilization of the available spectrum, as both technologies can use the same set of frequencies, coverage and all LTE users

(which of course do support NSA) would benefit from the NSA capacity and throughput enhancements.

Typical example is the LTE 700/800/1800 MHz with the 5G NR 700/800/1800 or even 2100/2600 MHz. .



- Collocating 5G with LTE in a Non-Standalone (NSA) deployment on same or similar bands allows for a smoother migration path. LTE serves as the anchor for signaling and initial connectivity, while 5G NR on the same or similar coverage triggers the ENDC scenario providing the necessary additional capacity and capabilities. This gradual approach is less disruptive than a complete standalone 5G deployment.



- The collocation strategy enables the use of Dual Connectivity with CA aggregation solutions, where user devices can

simultaneously connect to both LTE and 5G networks and support EN-DC split bearer + LTE Spcell CA + SCG CA throughput enhancements.

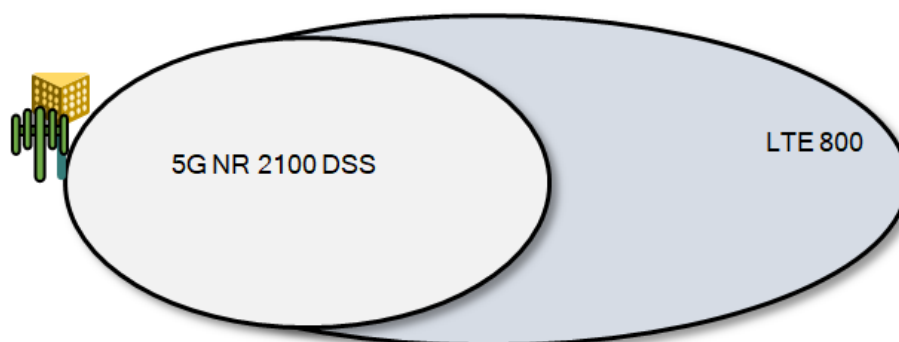
This scenario facilitates seamless handovers and enhances the overall user experience.

- Collocating 5G and LTE simplifies the integration of the two networks, as they can share some components such as base stations and backhaul infrastructure. This streamlines the deployment process and reduces the complexity of network management.
- Collocating 5G with LTE allows for wider coverage, as the existing LTE infrastructure can provide coverage in areas where 5G may not be deployed initially. This ensures a more comprehensive service footprint during the early stages of 5G NSA deployment.

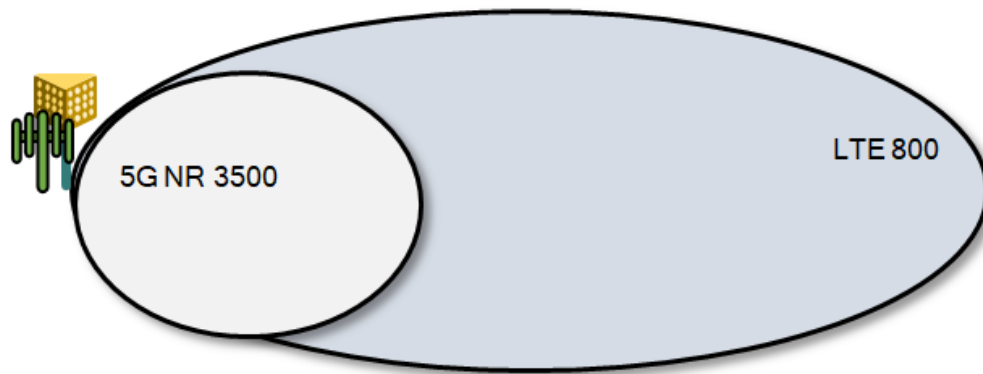
**3.2 Optimization scenario 2:** 5G NR collocation with pre-existing low band LTE, on the band combinations of LTE band 700/800/1800 with 5G NR DSS 1800/2100 or even 2600 MHz, keeping the footprint of LTE coverage and improving the 5G NR capacity in smaller footprint distances. DSS is vital to be used since it keeps the LTE capacity in most of the network topology, promoting also the NSA dual carrier performance.

Follows two typical and popular examples among operators with:

5G NR 2100 MHz DSS and LTE 700/800 MHz



5G NR C-band or even better mmW with LTE low band 700/800 MHz



## References

- [1] <https://www.ericsson.com/en/ran/spectrum-sharing>
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- [3] <https://forum.huawei.com/enterprise/en/introduction-to-5g-what-is-5g-nsa-networking/thread/667244787490766848-667213872962088960>
- [4] Nokia Technical White paper: *"Ten key rules of 5G deployment Enabling 1 Tbit/s/km<sup>2</sup> in 2030"*
- [5] Samsung Technical White paper: *"5G Standalone Architecture"*, January 2021
- [6] GSMA Association: *"5G Implementation Guidelines: NSA Option 3"*, February 2020
- [7] 3GPP TR 38.804 V1.0.0 (2017-03) Study on New Radio Access Technology; Radio Interface Protocol Aspects
- [8] 3GPP TR 36.842 V12.0.0 (2013-12) Study on Small Cell enhancements for E-UTRA and E-UTRAN; Higher layer aspects