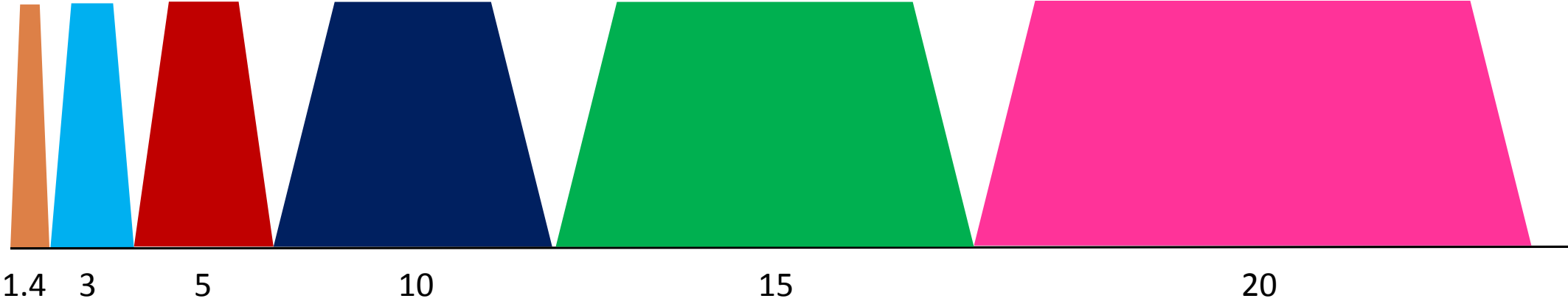


# Bandwidth Part (BWP) Concept in 5G

# Channel Bandwidth in 4G (LTE/LTE-A/LTE-A Pro)

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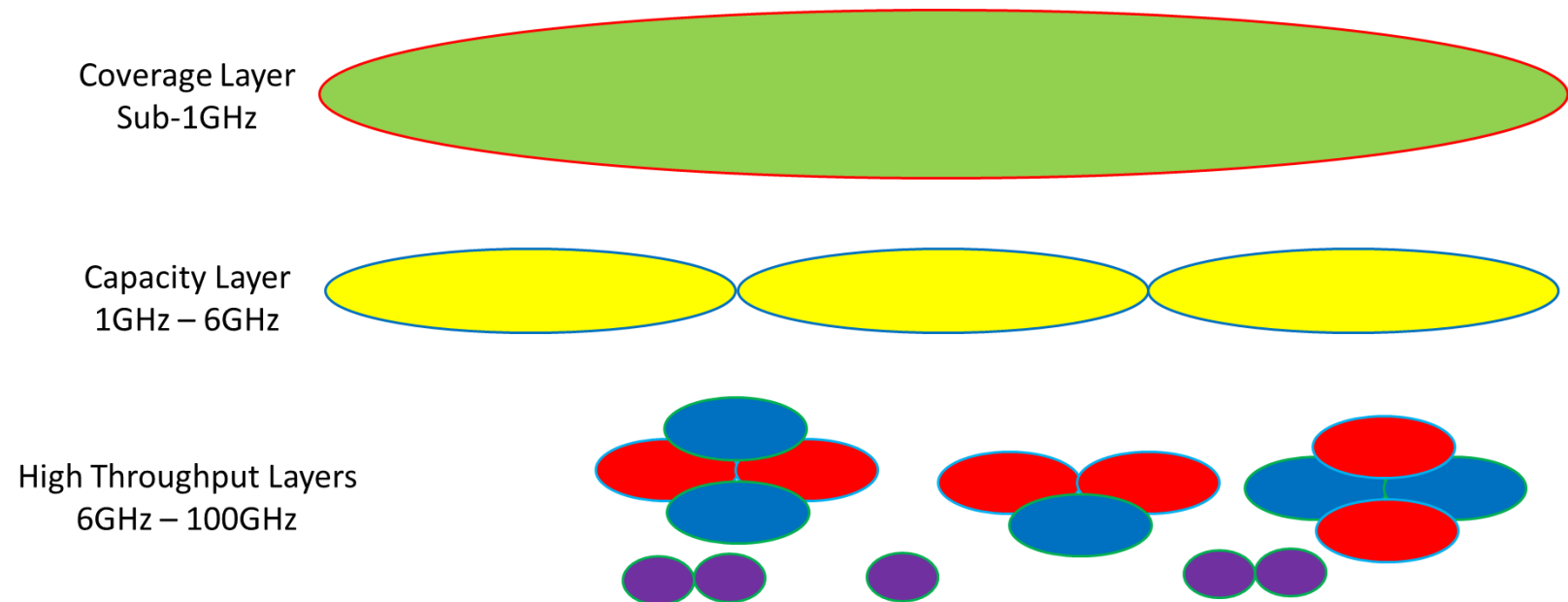
4G Bandwidths  
(MHz)



# 3GPP defined 5G Spectrum Ranges

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- 3GPP defines new NR (New Radio) bands in FR1 and FR2 in 3GPP Rel.15 NR
- FR1: 450 MHz – 6 GHz
  - Upper range is changing to 7.125 GHz
- FR2: 24.25 GHz – 52.6 GHz



# Bandwidth of FR1 5G bands

Release 15

24

3GPP TS 38.101-1 V15.3.0 (2018-09)

NR Band	NR band / SCS / UE Channel bandwidth												
	SCS kHz	5 MHz	10 <sup>1,2</sup> MHz	15 <sup>2</sup> MHz	20 <sup>2</sup> MHz	25 <sup>2</sup> MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n1	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60		Yes	Yes	Yes								
n2	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60		Yes	Yes	Yes								
n3	15	Yes	Yes	Yes	Yes	Yes	Yes						
	30		Yes	Yes	Yes	Yes	Yes						
	60		Yes	Yes	Yes	Yes	Yes						
n5	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60												
n7	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60		Yes	Yes	Yes								
n8	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60												
n12	15	Yes	Yes	Yes									
	30		Yes	Yes									
	60												
n20	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60												
n25	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60		Yes	Yes	Yes								
n28	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60												
n34	15	Yes	Yes	Yes									
	30		Yes	Yes									
	60		Yes	Yes									
n38	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60		Yes	Yes	Yes								
n39	15	Yes	Yes	Yes	Yes	Yes	Yes	Yes					
	30		Yes	Yes	Yes	Yes	Yes	Yes					
	60		Yes	Yes	Yes	Yes	Yes	Yes					

Release 15

25

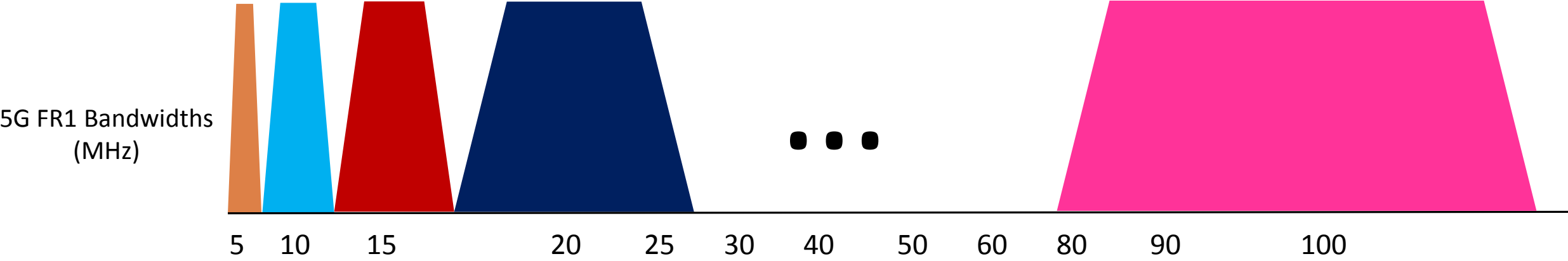
3GPP TS 38.101-1 V15.3.0 (2018-09)

NR Band	NR band / SCS / UE Channel bandwidth												
	SCS kHz	5 MHz	10 <sup>1,2</sup> MHz	15 <sup>2</sup> MHz	20 <sup>2</sup> MHz	25 <sup>2</sup> MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n71	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60												
n74	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60		Yes	Yes	Yes								
n75	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60		Yes	Yes	Yes								
n76	15	Yes											
	30												
	60												
n77	15		Yes	Yes	Yes			Yes	Yes				
	30		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes
	60		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes
n78	15		Yes	Yes	Yes			Yes	Yes				
	30		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes
	60		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes
n79	15							Yes	Yes				
	30							Yes	Yes	Yes	Yes		Yes
	60							Yes	Yes	Yes	Yes		Yes
n80	15	Yes	Yes	Yes	Yes	Yes	Yes						
	30		Yes	Yes	Yes	Yes	Yes						
	60		Yes	Yes	Yes	Yes	Yes						
n81	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60												
n82	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60												
n83	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60												
n84	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60		Yes	Yes	Yes								
n86	15	Yes	Yes	Yes	Yes				Yes				
	30		Yes	Yes	Yes				Yes				
	60		Yes	Yes	Yes				Yes				

NOTE 1: 90% spectrum utilization may not be achieved for 30kHz SCS.  
NOTE 2: 90% spectrum utilization may not be achieved for 60kHz SCS.  
NOTE 3: This UE channel bandwidth is applicable only to downlink.

# Channel Bandwidth in 5G: FR1

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# Bandwidth of FR2 5G bands

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Release 15

3GPP TS 38.101-2 V15.3.0 (2018-09)

**Table 5.3.5-1: Channel bandwidths for each NR band**

Operating band / SCS / UE channel bandwidth					
Operating band	SCS kHz	50 MHz	100 MHz	200 MHz	400 MHz
n257	60	Yes	Yes	Yes	
	120	Yes	Yes	Yes	Yes
n258	60	Yes	Yes	Yes	
	120	Yes	Yes	Yes	Yes
n260	60	Yes	Yes	Yes	
	120	Yes	Yes	Yes	Yes
n261	60	Yes	Yes	Yes	
	120	Yes	Yes	Yes	Yes

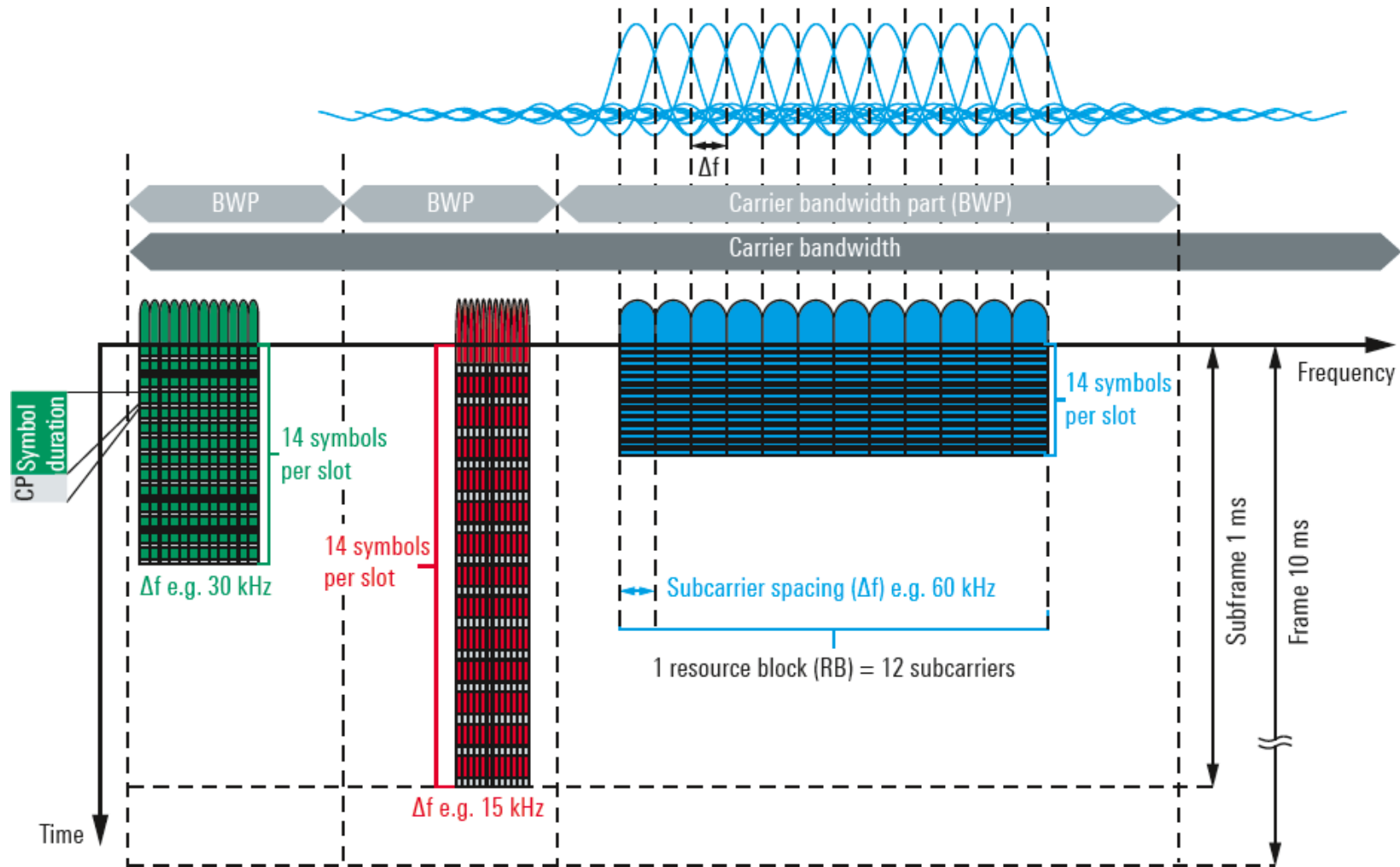
# Channel Bandwidth in 5G: FR2

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5G FR2 Bandwidths  
(MHz)



# ~~Carrier~~ Bandwidth Part (BWP)



Picture Source:  
Rohde & Schwarz

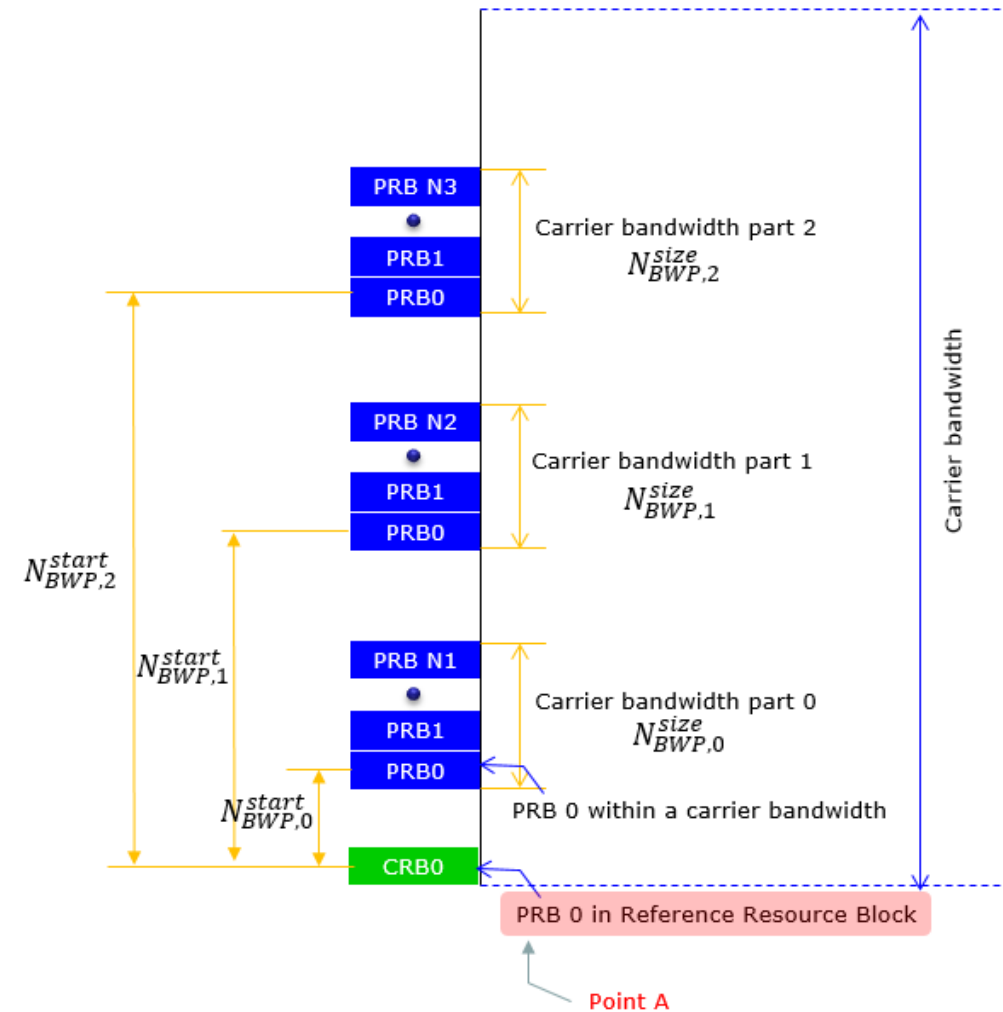
# Why BWP?

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- In LTE, maximum BW is 20 MHz
  - Its easy for all devices to support this bandwidth
- In 5G NR, maximum BW is 400 MHz for FR2
  - Cheaper devices may not want to support this large bandwidth
  - A device does not need to monitor the whole of bandwidth for power consumption reduction
- BWP allows device-side receiver 'bandwidth adaptation' to reduce the device energy consumption
  - A small BW is used for monitoring control channels and receiving low/medium data rates, while dynamically using a wideband receiver only when needed to support very high data rates.
- Rel-15 only supports single active BWP but this will change in future releases

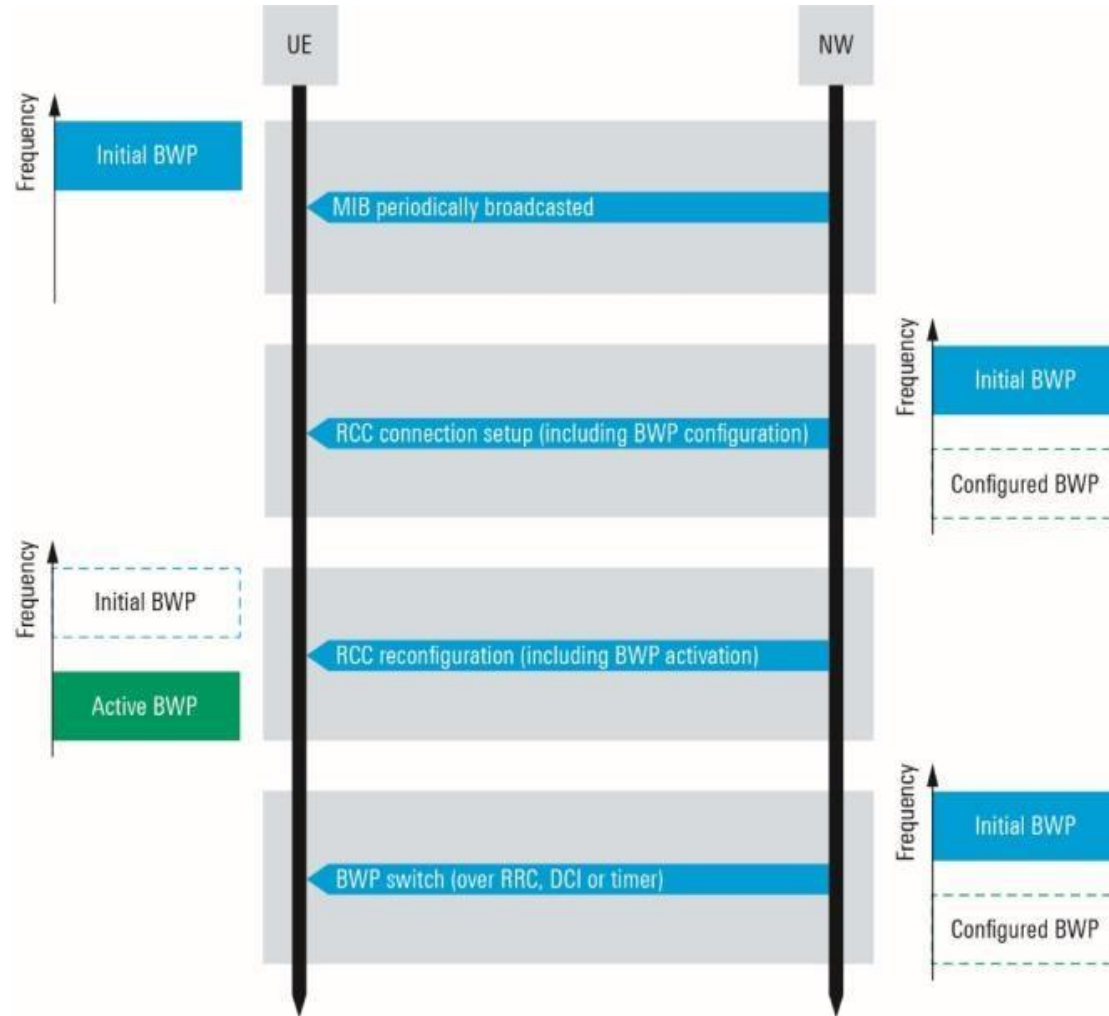
# BandWidth Part (BWP) in Specs

- BWP was referred to as 'Carrier Bandwidth Part' in early version of 3GPP TS 38.211:4.4.5 but renamed as Bandwidth Part in the latest version
- BWP is a contiguous set of physical resource blocks (PRB), selected from a contiguous subset of the common resource blocks (CRB) for a given numerology on a given carrier. It can be illustrated as shown.
- A UE can be configured with up to 4 BWPs in the downlink and with up to 4 BWPs in the uplink with a single downlink bandwidth part being active at a given time.
- If a UE is configured with a supplementary uplink (SUL) the UE can in addition be configured with up to four bandwidth parts in the supplementary uplink with a single supplementary uplink bandwidth part being active at a given time.



Picture Source: [ShareTechNote](https://www.sharetechnote.com)

# BWP Configuration & Switching Signalling



Picture Source:  
Rohde & Schwarz

# 5G DCI (Downlink Control Information)

## Format 0\_1

This is used for the scheduling of PUSCH in one cell.

Field (Item)	Bits	Reference
Identifier for DCI formats	1	
Carrier indicator	0 or 3	
UL/SUL Indicator	0,1	0 - bit for UE not configured with SUL in the cell 1 - bit for UEs configured with SUL in the cell
Bandwidth part indicator	0,1,2	Determined by <a href="#">BandwidthPart-Config</a> in higher layer message and <a href="#">38.212 - Table 7.3.1.1.2-1</a>
Frequency domain resource assignment	Variable	<a href="#">Variable with Resource Allocation Type</a>
Time domain resource assignment	4	Carries the row index of the items in <a href="#">pusch_allocationList</a> in RRC Number of Bit Length is determined by $\log_2(I)$ , where I is the number of elements in <a href="#">pusch_allocationList</a> in RRC
Frequency Hopping Flag	0,1	
Modulation and coding scheme	5	<a href="#">38.214 - 6.1.4</a> (See <a href="#">this table</a> )
New data indicator	1	
Redundancy version	2	0,1,2,3
HARQ process number	4	
1st Downlink assignment index	1,2	
2nd Downlink assignment index	0,2	
TPC command for scheduled PUSCH	2	
SRS resource indicator	Variable	<a href="#">Determined by RRC Parameter SRS-SetUse</a>
Precoding information and number of layers (TPMI)	0,2,3,4,5,6	Determined by <a href="#">uITxConfig_Number of Antenna ports_PUSCH-tp_ULmaxRank</a>
Antenna ports	2,3,4,5	Determined by <a href="#">PUSCH-tp_DL-DMRS-config-type_DL-DMRS-config-max-len_Rank</a>
SRS request	2	<a href="#">Table 7.3.1.1.2-24</a>
CSI request	0,1,2,3,4,5,6	Determined by ReportTriggerSize in RRC message
CBG transmission information	0,2,4,6,8	Determined by maxCodeBlockGroupPerTransportblock in RRC message
PTRS - DMRS Association	0,2	Determined by <a href="#">UL-PTRS-present_PUSCH-tp</a> in RRC Message
beta_offsetr Indicator	0,2	0 - if uci-on-PUSCH.dynamic = Not Configured 2 - otherwise, see <a href="#">Table 7.3.1.1.2-27</a>
DMRS Sequence Initialization	0,1	0 - if PUSCH-tp=Disabled 1 - if PUSCH-tp=Enabled
UL-SCH Indicator	1	0 - UL-SCH shall not be transmitted on the PUSCH 1 - UL-SCH shall be transmitted on the PUSCH

For more details see: [ShareTechNote](#)

## Format 1\_1

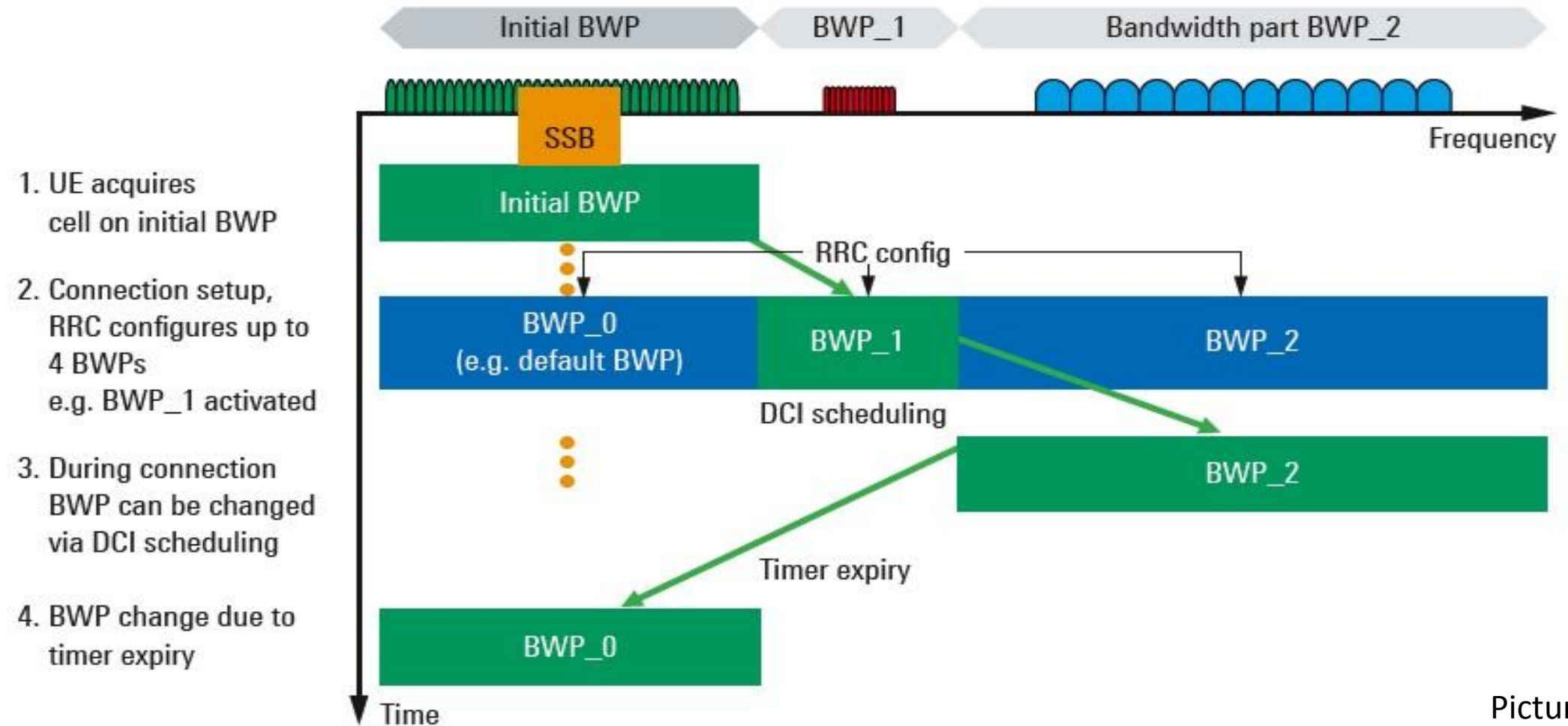
This is used for the scheduling of PDSCH in one cell.

Field (Item)	Bits	Reference
Carrier indicator	0,3	
Identifier for DCI formats	1	Always set to 1, indicating a DL DCI format
Bandwidth part indicator	0,1,2	
Frequency domain resource assignment	Variable	<a href="#">Variable with Resource Allocation Type</a>
Time domain resource assignment	4	Carries the row index of the items in <a href="#">pdsch_allocationList</a> in RRC
VRB-to-PRB mapping	0,1	0 bit if only resource allocation type 0 is configured or if interleaved VRB-to-PRB mapping is not configured by high layers; 1 bit according to <a href="#">Table 7.3.1.1.2-33</a> otherwise, only applicable to resource allocation type 1
PRB bundling size indicator	0,1	0 bit if the higher layer parameter prb-BundlingType is not configured or is set to 'static' 1 bit if the higher layer parameter prb-BundlingType is set to 'dynamic'
Rate matching indicator	0,1,2	Bit size is determined by higher layer parameters rateMatchPatternGroup1 and rateMatchPatternGroup2.
ZP CSI-RS Trigger	0,1,2	
Modulation and coding scheme [TB1]	5	
New data indicator [TB1]	1	
Redundancy version [TB1]	2	
Modulation and coding scheme [TB2]	5	
New data indicator [TB2]	1	
Redundancy version [TB2]	2	
HARQ process number	4	
		4 bits if more than one serving cell are configured in the DL and the higher layer parameter pdsch-HARQACK-Codebook=dynamic, where the 2 MSB bits are

< 38.212 v15.3.0 - Table 7.3.1.1.2-1: Bandwidth part indicator >

Value of BWP indicator field		Bandwidth part
1 bit	2 bits	
0	0	First bandwidth part configured by higher layers
1	1	Second bandwidth part configured by higher layers
	10	Third bandwidth part configured by higher layers
	11	Fourth bandwidth part configured by higher layers

# BWP Switching



Picture Source:  
Rohde & Schwarz

# Free eBook from Rohde & Schwarz (coming soon)

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The 5G New Radio eBook from [Rohde & Schwarz](#)

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