



Implementing Flexible Small Cell Open RAN

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SCF251 FR1 Reference Design paper



- Some of the themes discussed in these slides are informed by the work done by the SCF251 “FR1 Reference Design”
- Contributors:



- May 2022 cover feature



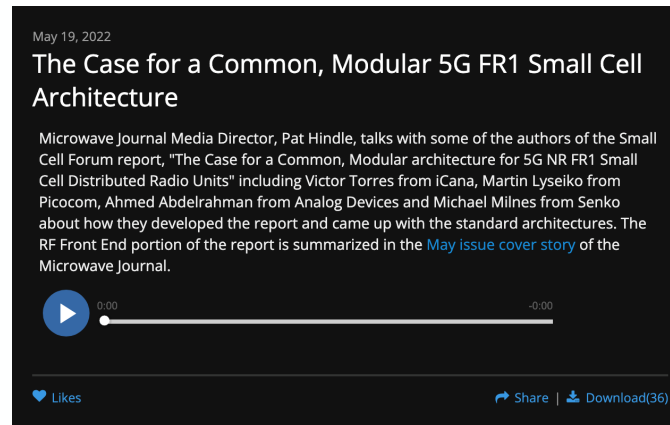
Anatomy of the 5G Small Cell

May 13, 2022 Patrick Hindle, Microwave Journal No Comments



The industry has been talking about the small cell market for many years as being on the verge of huge growth, but while it is a sizable market and there has been some growth, it has not taken off as quickly as many expected. Though with the emergence of 5G, it is poised to do so; meeting the goals of increased capacity in dense areas and the large number of connections needed for IoT applications. In 2020, the 5G small cell market was \$741 million and is expected to grow to about \$18 billion by 2028, according to Forbes Business Insights, exhibiting a compound average growth rate of 54 percent.

The Small Cell Forum recently published “5G NR FR1 Reference Design, the case for a common, modular architecture” that outlines the design of small cells in detail (Document 251.10.01). This article is based on sections 3.2-3.4, outlining the architectures for the RF section of small cells.



<https://podcasts.microwavejournal.com/e/the-case-for-a-common-modular-5g-fr1-small-cell-architecture/>

<https://www.microwavejournal.com/articles/38108-anatomy-of-the-5g-small-cell>



5G NR FR1 Reference Design

The case for a common, modular architecture for 5G NR FR1 small cell distributed radio units

DECEMBER 2021



DOCUMENT 251.10.01

www.smallcellforum.org

<https://www.smallcellforum.org/press-releases/small-cell-forum-proposes-reference-design-for-5g-nr-fr1-small-cells/>

Agenda

- 5G Small Cell Drivers
- 5G Small Cell Architecture
- Dimensions of flexibility
 - Spectrum
 - Performance
 - Functional split
- Summary



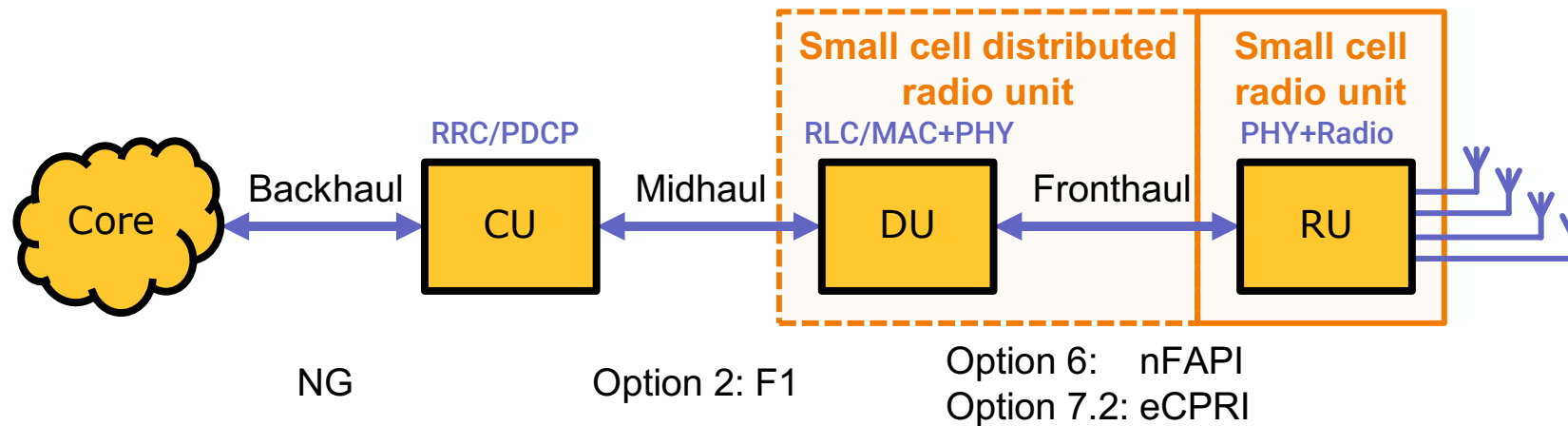
5G Small Cell Drivers

- ◆ Deployment
 - ◆ Network densification
 - ◆ Private networks / edge computing
 - ◆ Neutral host <- *interesting use case*
- ◆ Open, multi-vendor ecosystem



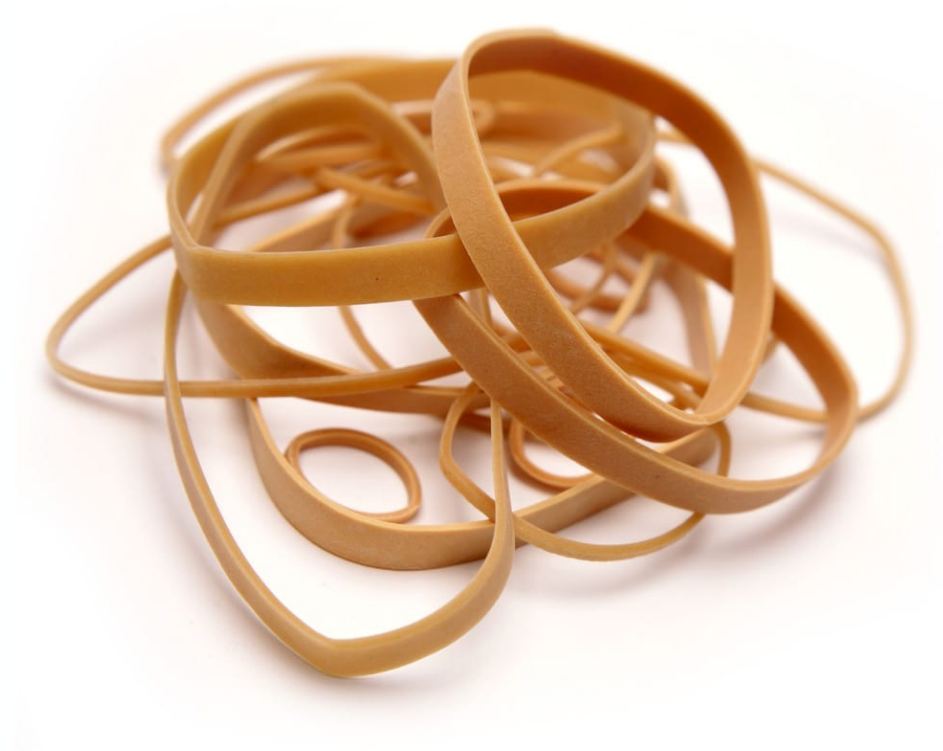
5G Small Cell Architecture

- ❖ Disaggregated RAN functions
 - ❖ Central Unit – RRC/PDCP (ciphering)
 - ❖ Distributed Unit – RLC/MAC + (PHY)
 - ❖ Radio Unit – PHY + Radio
- ❖ Fronthaul / Midhaul
 - ❖ Ethernet, coupled with precision time protocol for network synchronisation

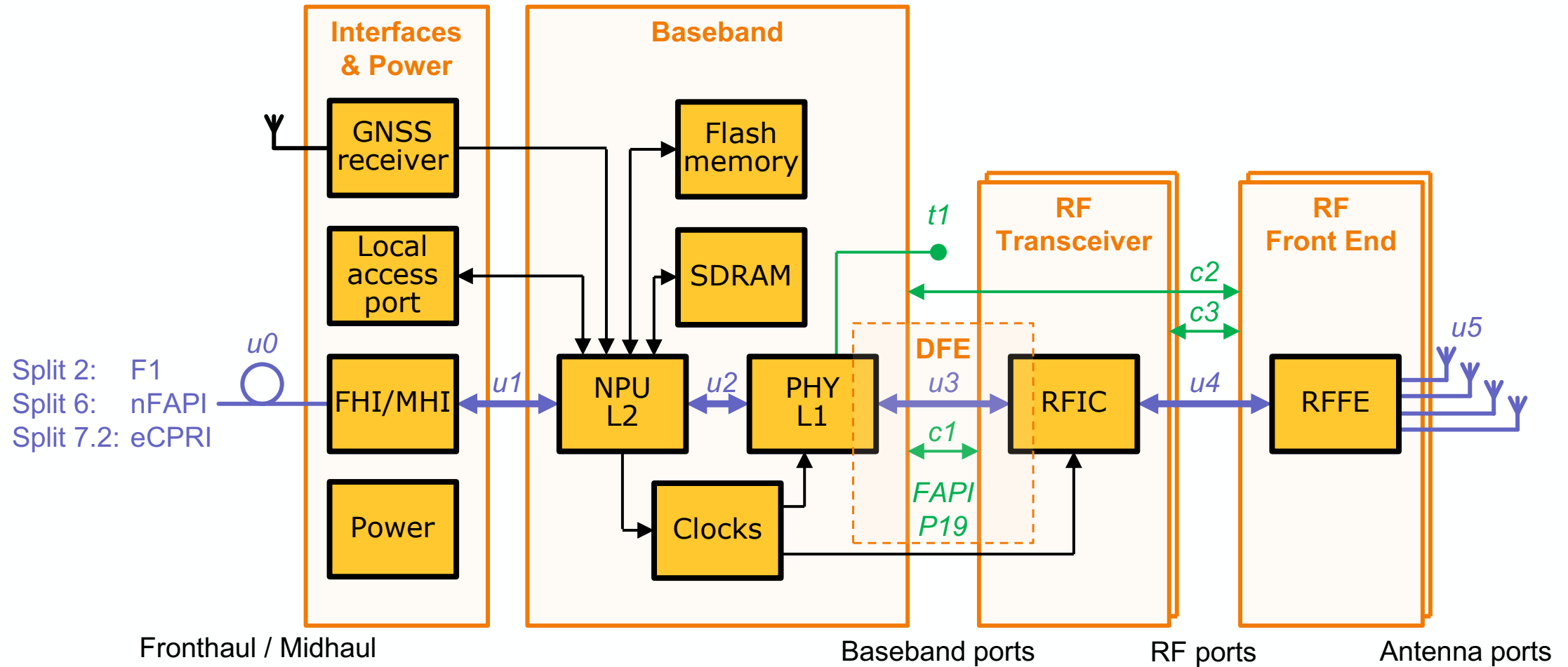


Dimensions of flexibility

- ◆ Spectrum
 - ◆ Bands, total bandwidth
 - ◆ 4G/5G
 - ◆ Duplexing
- ◆ Performance
 - ◆ Throughput
 - ◆ Transmission power
- ◆ Functional split
 - ◆ Split 2, 6, 7.2
 - ◆ Software defined split

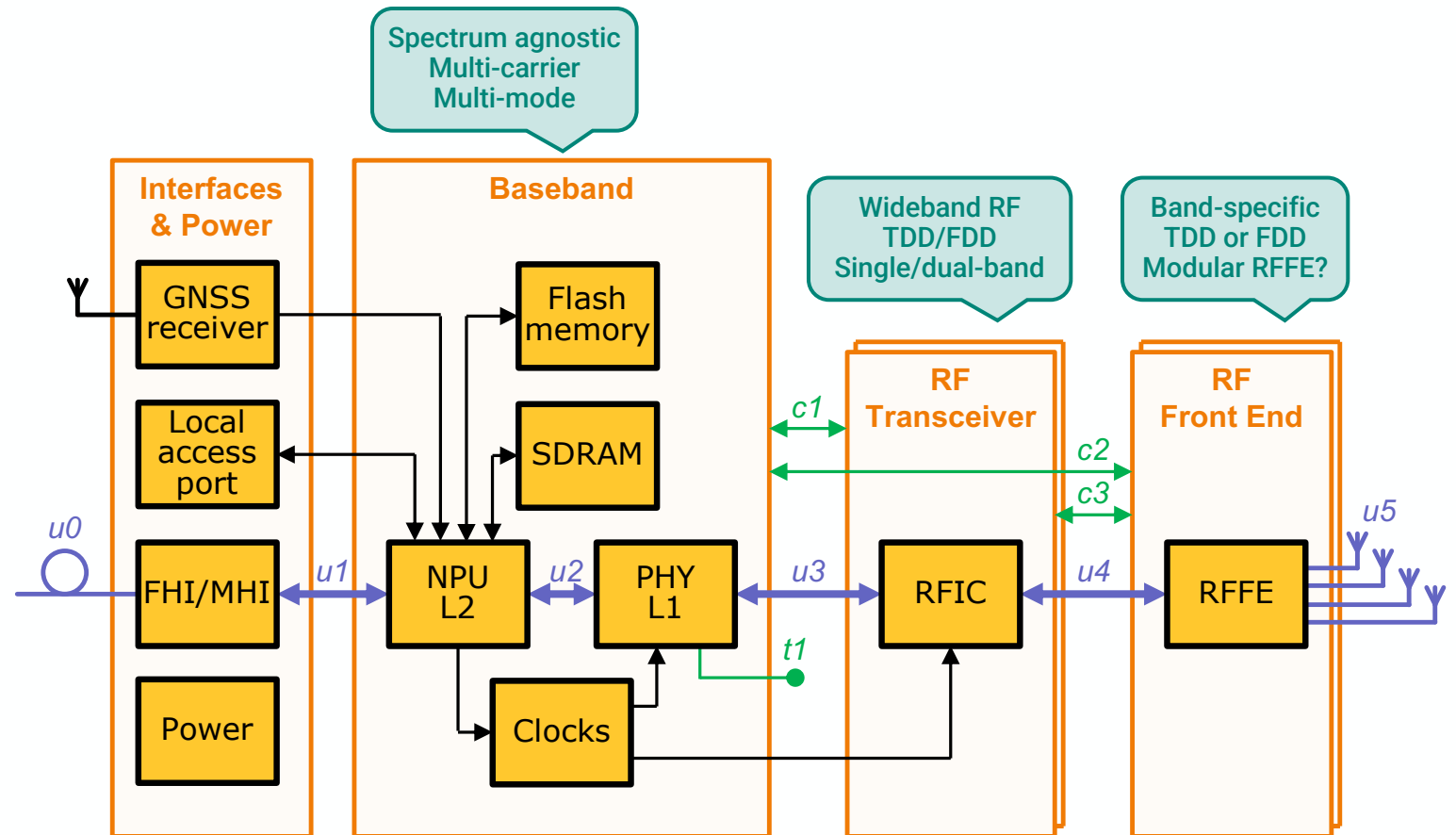


Reference Small Cell (SCF251, with DFE)



Spectrum Flexibility

- ◆ Typified by Neutral Host use case
 - ◆ Multi-carrier
 - ◆ Multi-band
 - ◆ Mixed TDD / FDD
 - ◆ Mixed mode 4G/5G
- ◆ Baseband fully flexible
- ◆ RFIC wideband, modulation agnostic
- ◆ RFFE is main point of pain...



UK MNO Spectrum

B28

B20

B8

B32

B3

B39

B1

Mobile and Wireless Broadband below 5 GHz				Ofcom			
Jan-22							
Frequency Band	Uplink	Downlink	Bandwidth MHz	EE	Telefónica	Three	Vodafone
700 MHz							
703.0 - 713.0		758.0 - 768.0	2 x 10		Telefónica		
713.0 - 723.0		768.0 - 778.0	2 x 10			Three	
723.0 - 733.0		738.0 - 758.0 778.0 - 788.0	20 2 x 10	EE			
800 MHz							
832.0 - 837.0		791.0 - 796.0	2 x 5			Three	
837.0 - 842.0		796.0 - 801.0	2 x 5	EE			
842.0 - 852.0		801.0 - 811.0	2 x 10				Vodafone
852.0 - 862.0		811.0 - 821.0	2 x 10		Telefónica		
900 MHz							
880.1 - 885.1		925.1 - 930.1	2 x 5				Vodafone
885.1 - 890.1		930.1 - 935.1	2 x 5		Telefónica		
890.1 - 902.5		935.1 - 947.5	2 x 12.4				Vodafone
902.5 - 914.9		947.5 - 959.9	2 x 12.4		Telefónica		
1400 MHz							
		1452.0 - 1472.0	20				Vodafone
		1472.0 - 1492.0	20			Three	
1800 MHz							
1710.1 - 1715.9		1805.1 - 1810.9	2 x 5.8		Telefónica		
1715.9 - 1721.7		1810.9 - 1816.7	2 x 5.8				Vodafone
1721.7 - 1736.7		1816.7 - 1831.7	2 x 15			Three	
1736.7 - 1781.7		1831.7 - 1876.7	2 x 45	EE			
1781.7 - 1785		1876.7 - 1880.0	2 x 3.3	Shared Access			
1880.0 - 1900.0			20	DECT cordless telephony			
1900 MHz							
1899.9 - 1909.9			10	EE			
1909.9 - 1914.9			5		Telefónica		
1914.9 - 1920.0			5.1			Three	
1900 / 2100 MHz							
1920.0 - 1920.3		2110.3 - 2124.9	0.3			Three	
1920.3 - 1934.9			2 x 14.6				
1934.9 - 1944.9		2124.9 - 2134.9	2 x 10		Telefónica		
1944.9 - 1959.7		2134.9 - 2149.7	2 x 14.8				Vodafone
1959.7 - 1979.7		2149.7 - 2169.7	2 x 20	EE			

https://www.ofcom.org.uk/_data/assets/pdf_file/0016/232108/frequency-allocations-mobile-broadband-below-5ghz.pdf

2300 MHz							
2350.0 - 2390.0		40		Telefónica			
2600 MHz							
2570.0 - 2595.0		25					Vodafone
2595.0 - 2620.0		25		Telefónica			
2600 MHz							
2500.0 - 2520.0	2620.0 - 2640.0	2 x 20					Vodafone
2520.0 - 2535.0	2640.0 - 2655.0	2 x 15		EE			
2535.0 - 2570.0	2655.0 - 2690.0	2 x 35		EE			
3410 - 3800 MHz							
3410.0 - 3460.0		50					Vodafone
3460.0 - 3480.0		20				Three	
3480.0 - 3500.0		20				UK Broadband	
3500.0 - 3540.0		40		Telefónica (until 31/12/2025)			Vodafone
3540.0 - 3580.0		40		EE			
3580.0 - 3600.0		20				UK Broadband	
3600.0 - 3680.0		80				UK Broadband	
3680.0 - 3720.0		40		EE			
3720.0 - 3760.0		40			Telefónica		Vodafone (until 31/12/2025)
3760.0 - 3800.0		40			Telefónica		
3800 - 4200 MHz							
3800				Shared Access			
3925.0 - 4009.0		84		UK Broadband			
4200							
Total (MHz):				370	256.4	338.6	271

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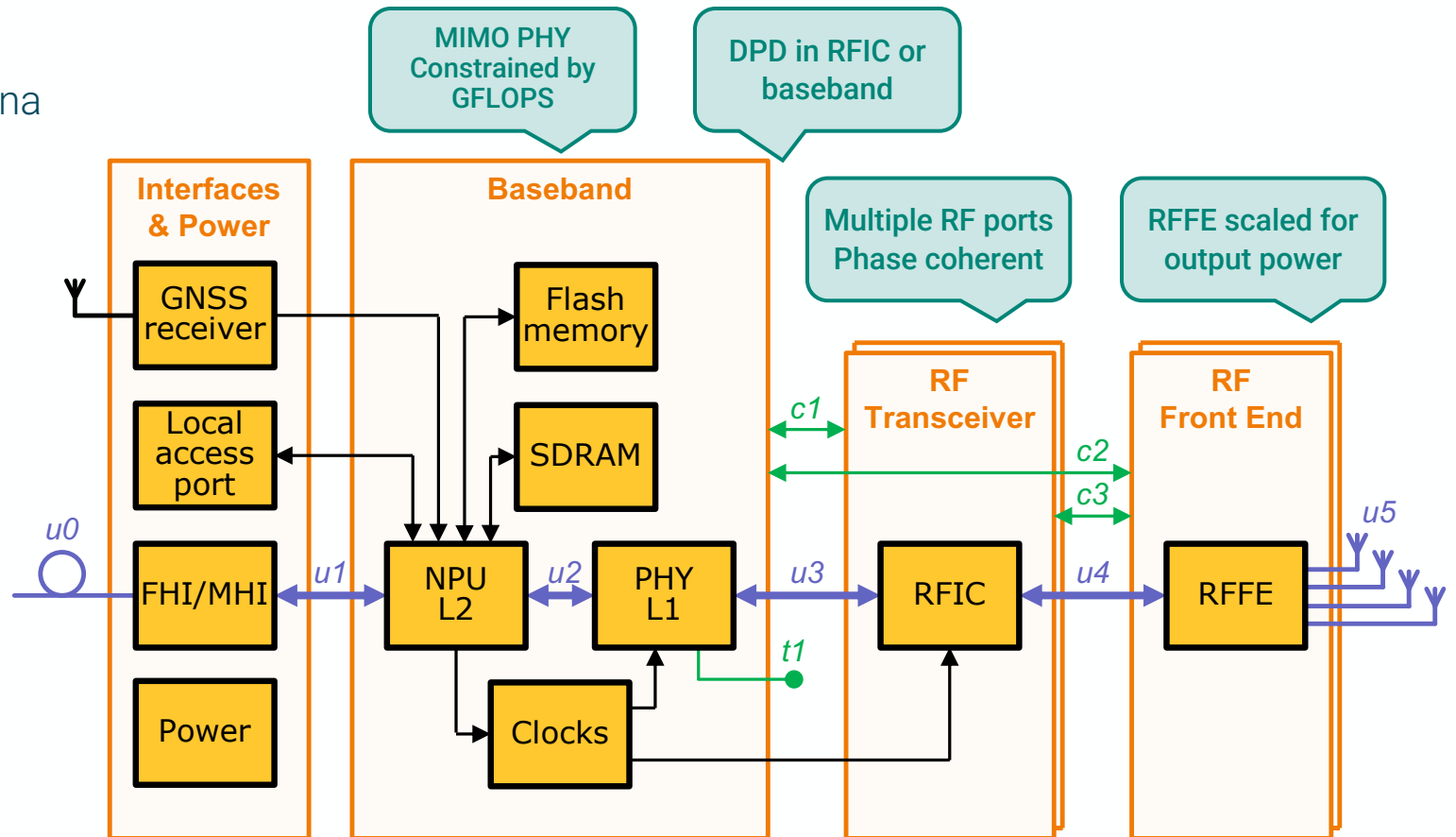
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Performance flexibility

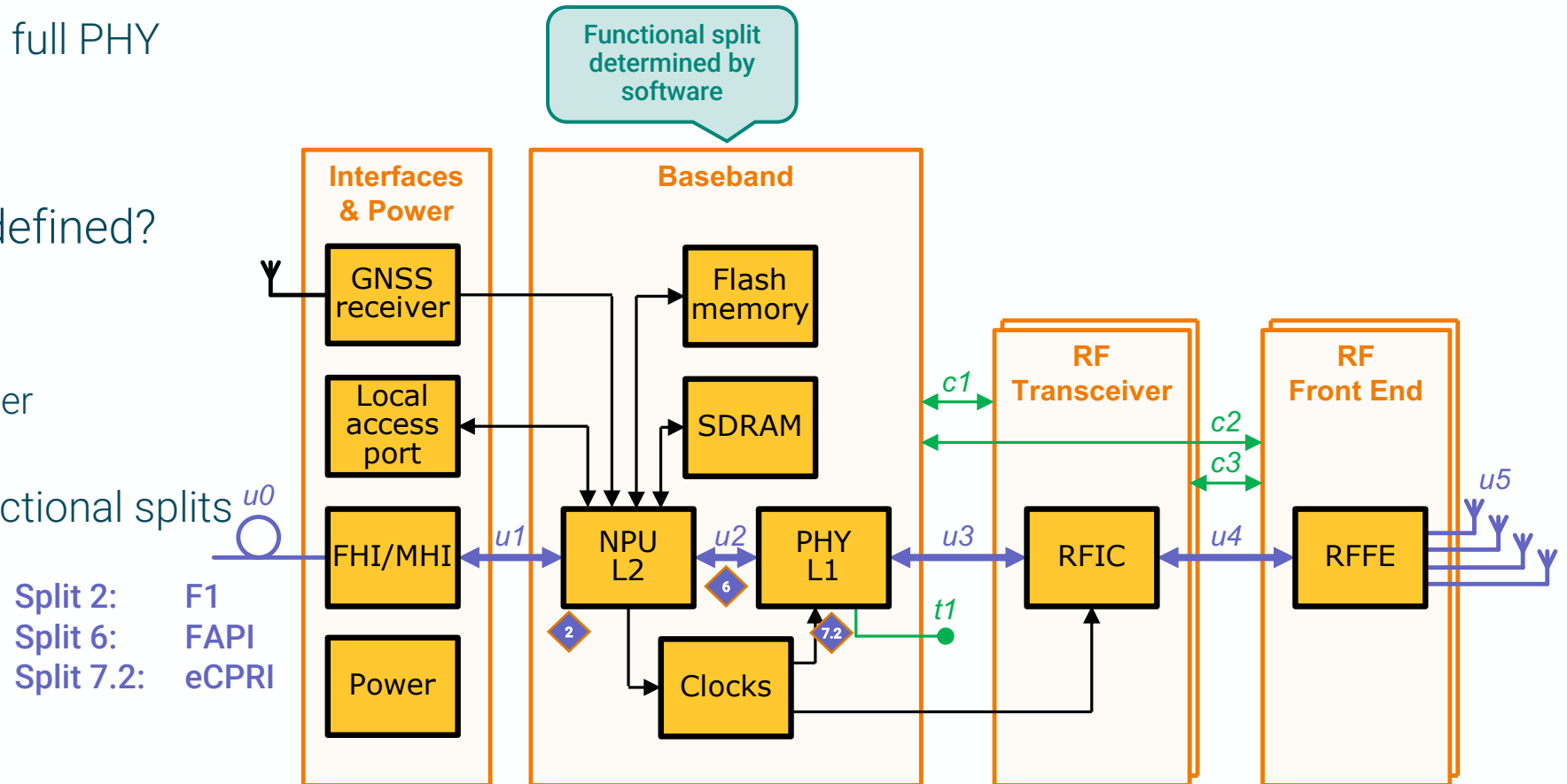
Throughput

- ◆ Total bandwidth
 - ◆ #Antennas x bandwidth per antenna
- ◆ Dimensioned across design
- ◆ Traded off against
 - ◆ Bandwidth
 - ◆ Multi-band operation
- ◆ e.g.
 - ◆ Single band 8T8R
 - ◆ Single band 4T4R, dual CA
 - ◆ Dual band 4T4R
 - ◆ Quad band 2T2R
 - ◆ or combinations of..
- ◆ Transmission power
 - ◆ Largely affects RFFE
 - ◆ DPD standard on small cells



Functional splits

- ◆ Contained within baseband
 - ◆ Split 2 - full L2 stack + full PHY
 - ◆ Split 6 – full PHY
 - ◆ Split 7.2 – low-PHY
- ◆ Can this be software defined?
 - ◆ Yes, but..
 - ◆ Constrained by
 - ◆ Total processing power
 - ◆ Micro-architecture
 - ◆ Not optimal for all functional splits



Summary

- ❖ 5G small cell architectures able to meet sub-6GHz needs
 - ❖ High-performance Baseband and RFIC can address all solutions
 - ❖ RF front-end main area of customisation
 - ❖ Trend to broadband / multi-band RF FE
- ❖ Any uncertainty around functional splits is manageable



<https://picocom.com/products/socs/pc802/>

<https://www.picocom.com/>



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Thank you