

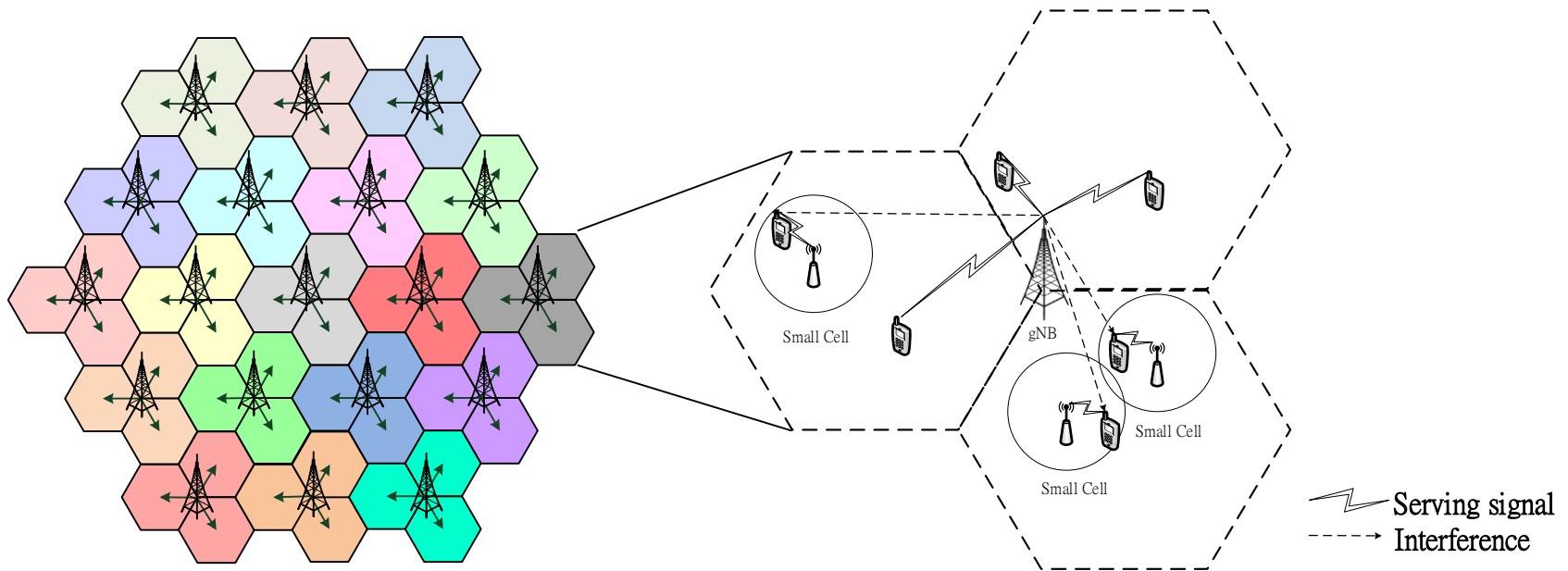
教育部「5G行動寬頻人才培育跨校教學聯盟計畫」 5G行動網路協定與核網技術聯盟中心

課程: 5G系統層模擬技術
第三週：系統層模擬器架構



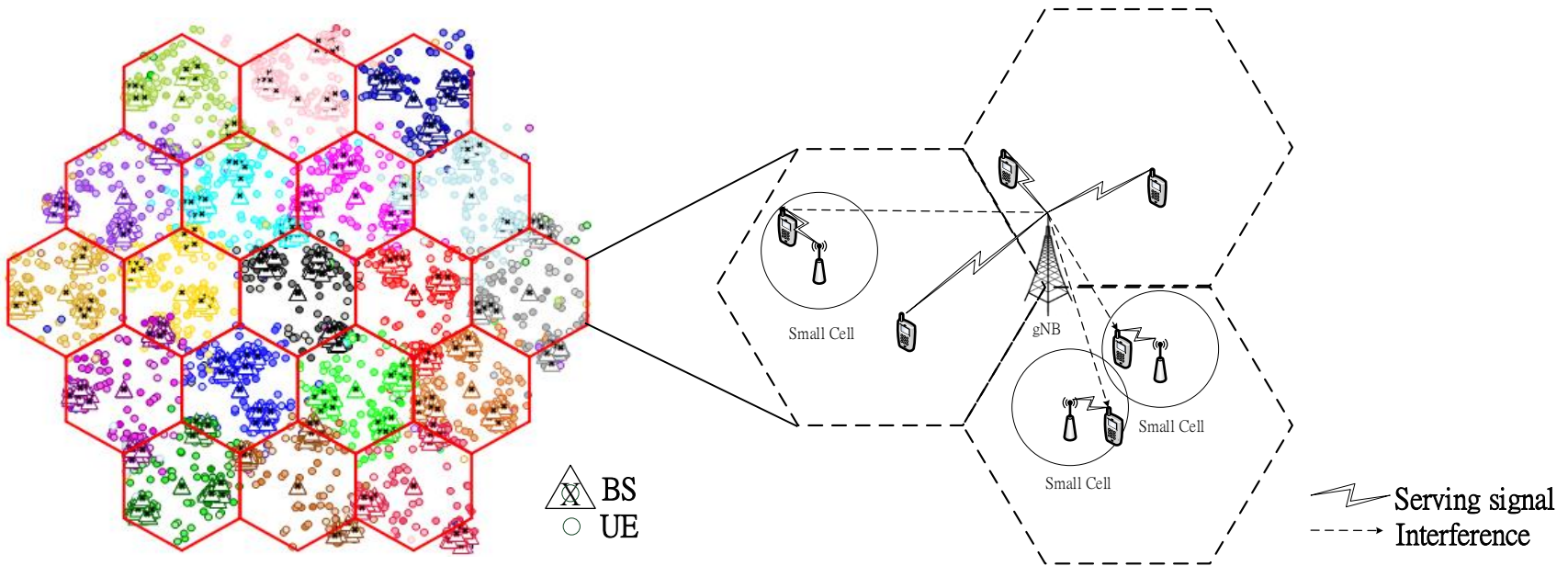
什麼是系統層級模擬器？

- 系統層級模擬器(System Level Simulation, SLS)
 - ◆ 模擬大量基地台與更大量的使用者設備之間錯綜複雜的排程、互動、傳送與干擾行為。



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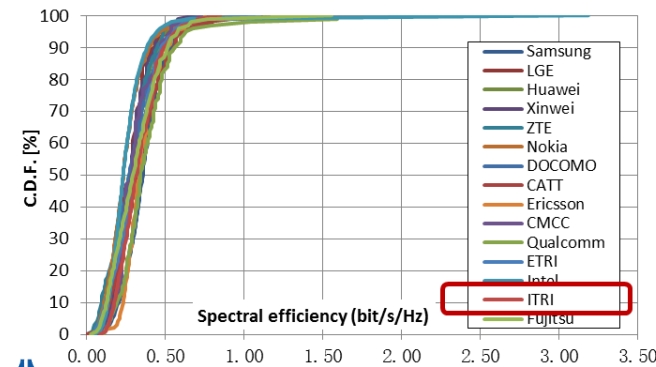
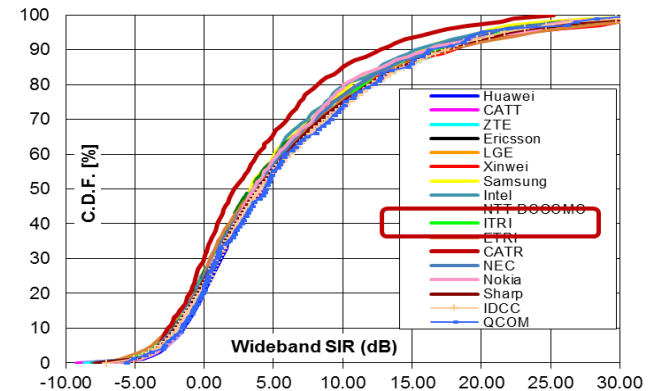
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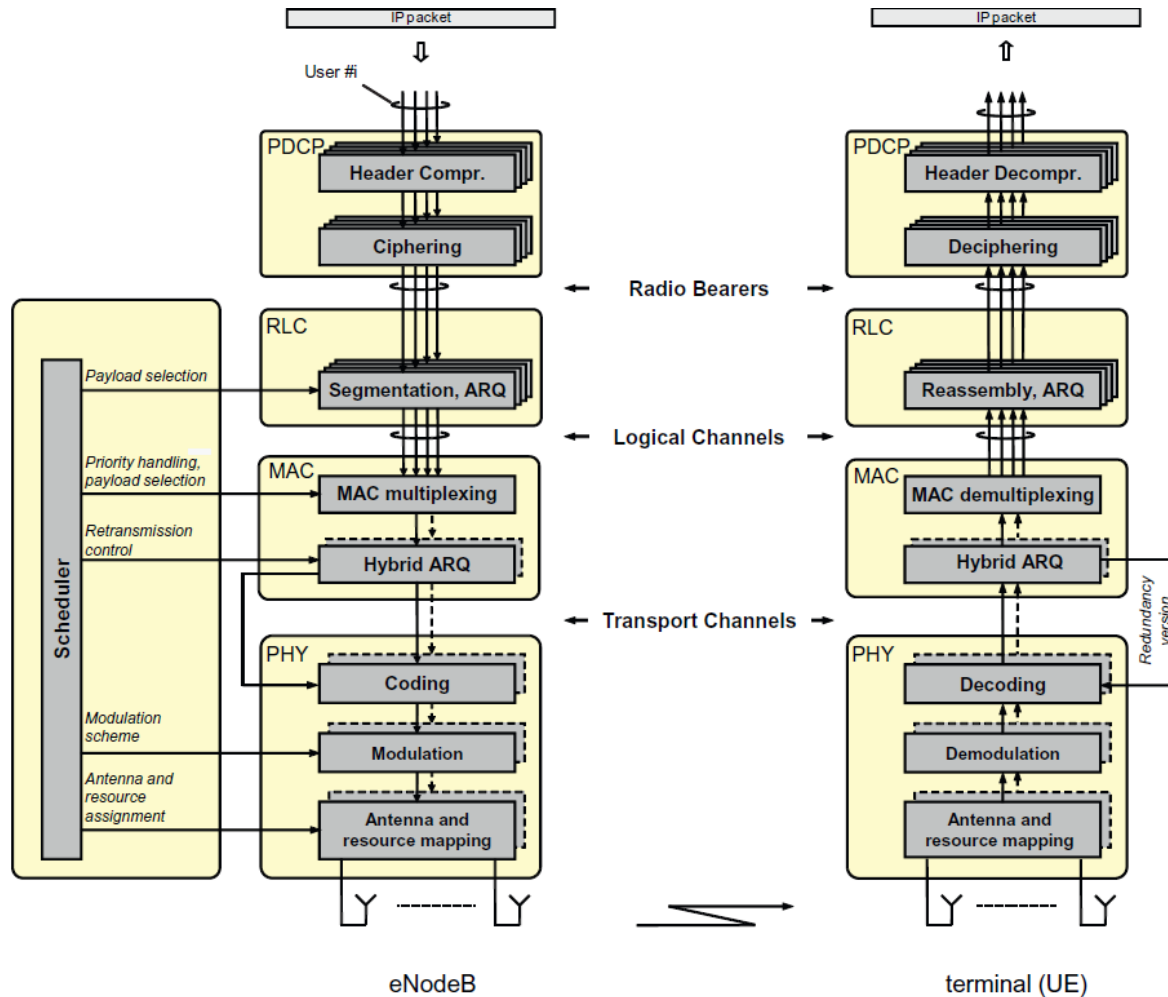
常用的觀察系統效能指標

- 系統吞吐量 (System Throughput)
 - 平均傳輸速率 (Avg. Data Rate)
 - ◆ Cell average packet throughput
 - ◆ UE average packet throughput
- 頻譜效率 (Spectrum Efficiency)
 - ◆ Cell spectrum efficiency
 - ◆ Cell edge user spectrum efficiency
- 封包平均重傳次數 (Avg. Packet Retx Number)
- 封包遺失率 (Packet Loss Rate)
- 封包延遲 (Latency)
- 公平性 (Fairness)

模擬結果收錄在TR38.900、TR38.802文件



LTE protocol architecture (DL)

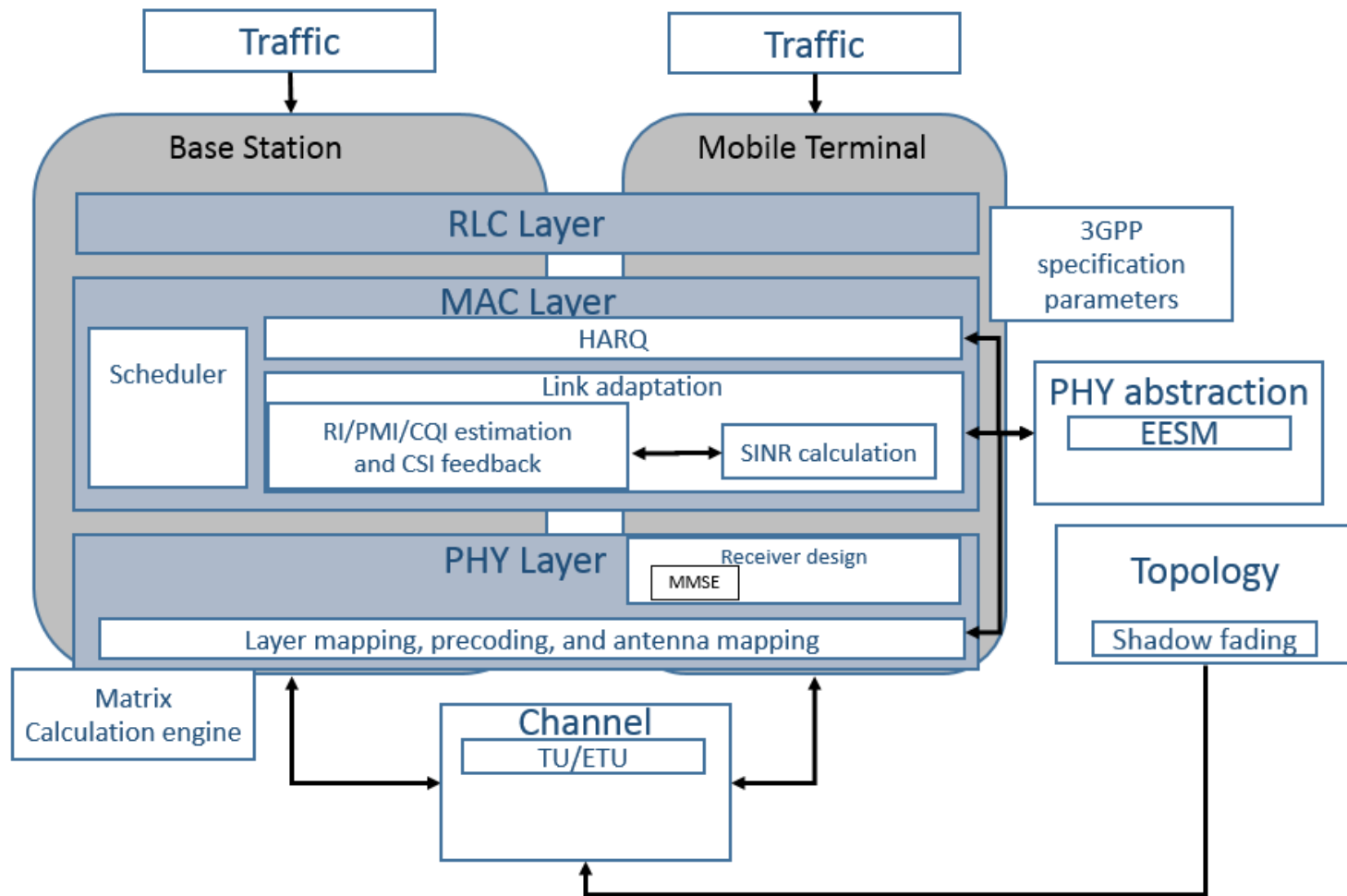


[1] Erik Dahlman, Stefan Parkvall, and Johan Sköld, 4G LTE/LTE-Advanced for Mobile Broadband_2011
FIGURE 8.4 LTE protocol architecture (downlink).

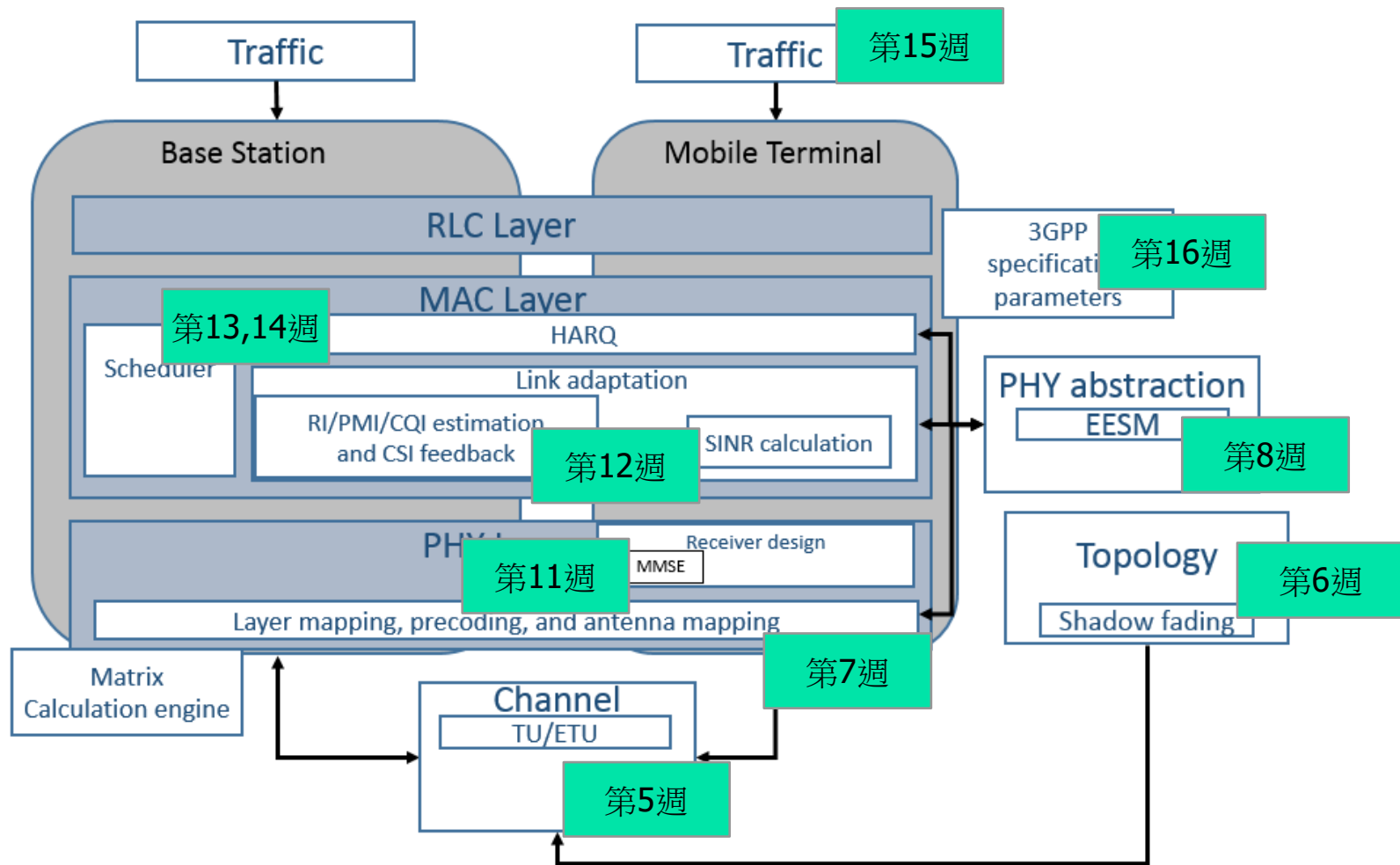


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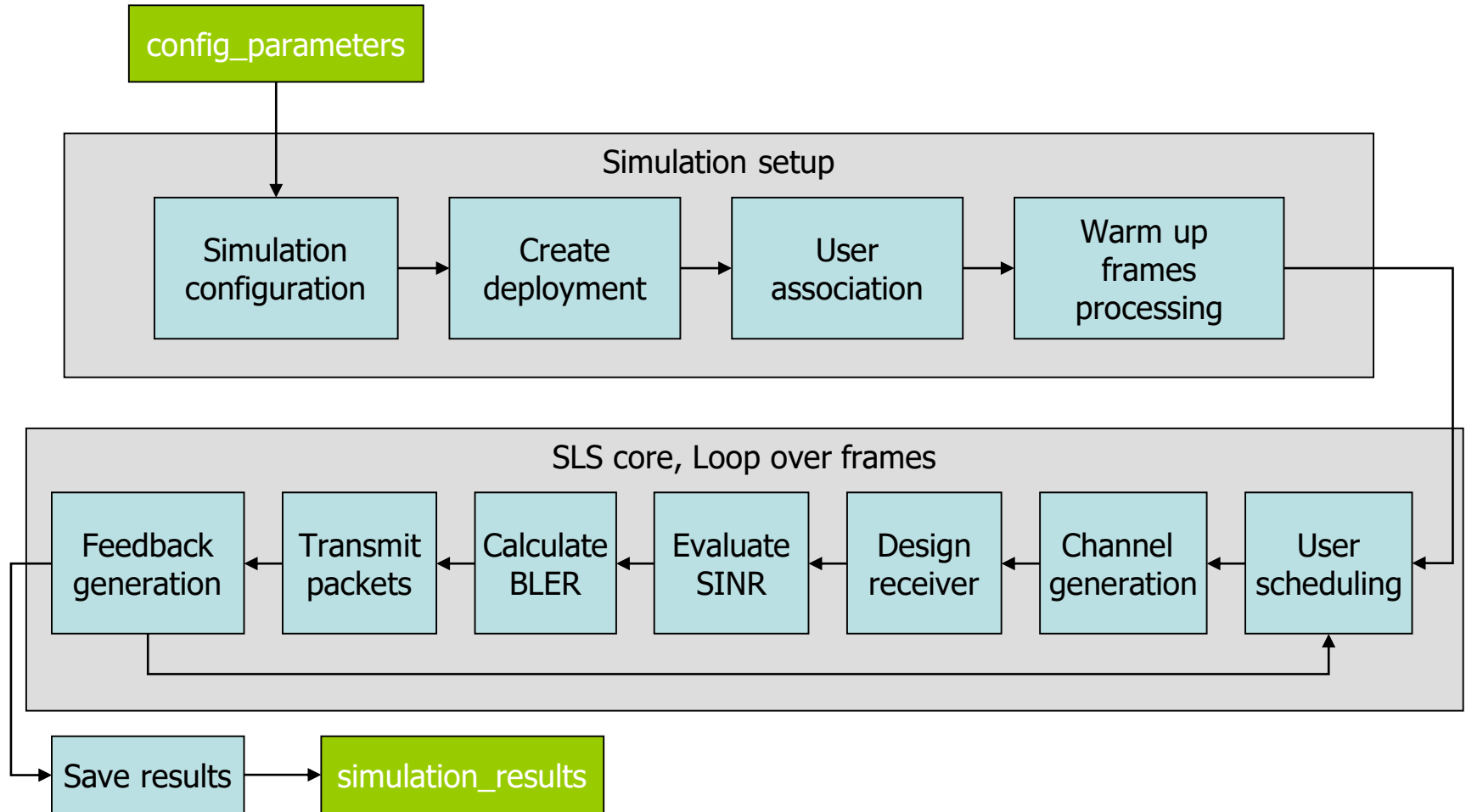
System level simulator architecture (ITRI SLS)



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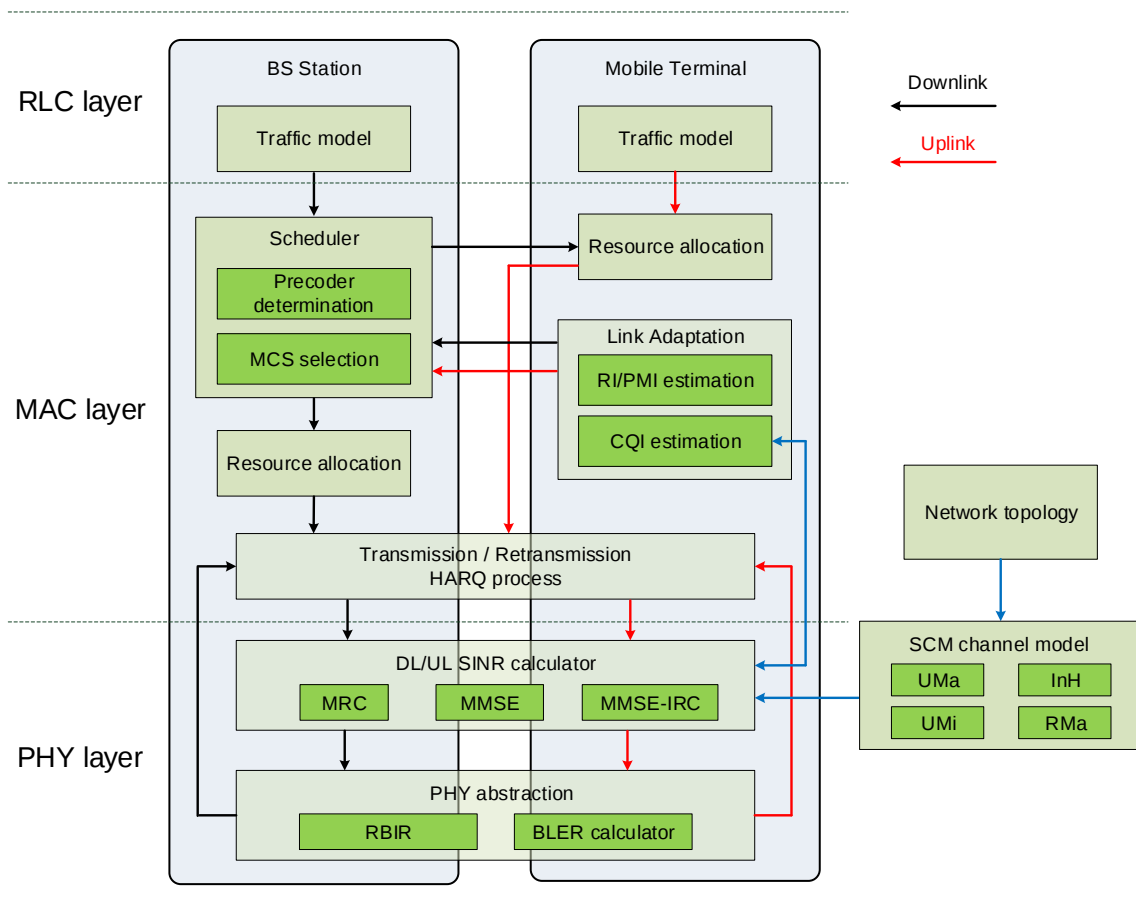


A typical SLS procedure



WiSE 系統層級模擬器 – 功能區塊

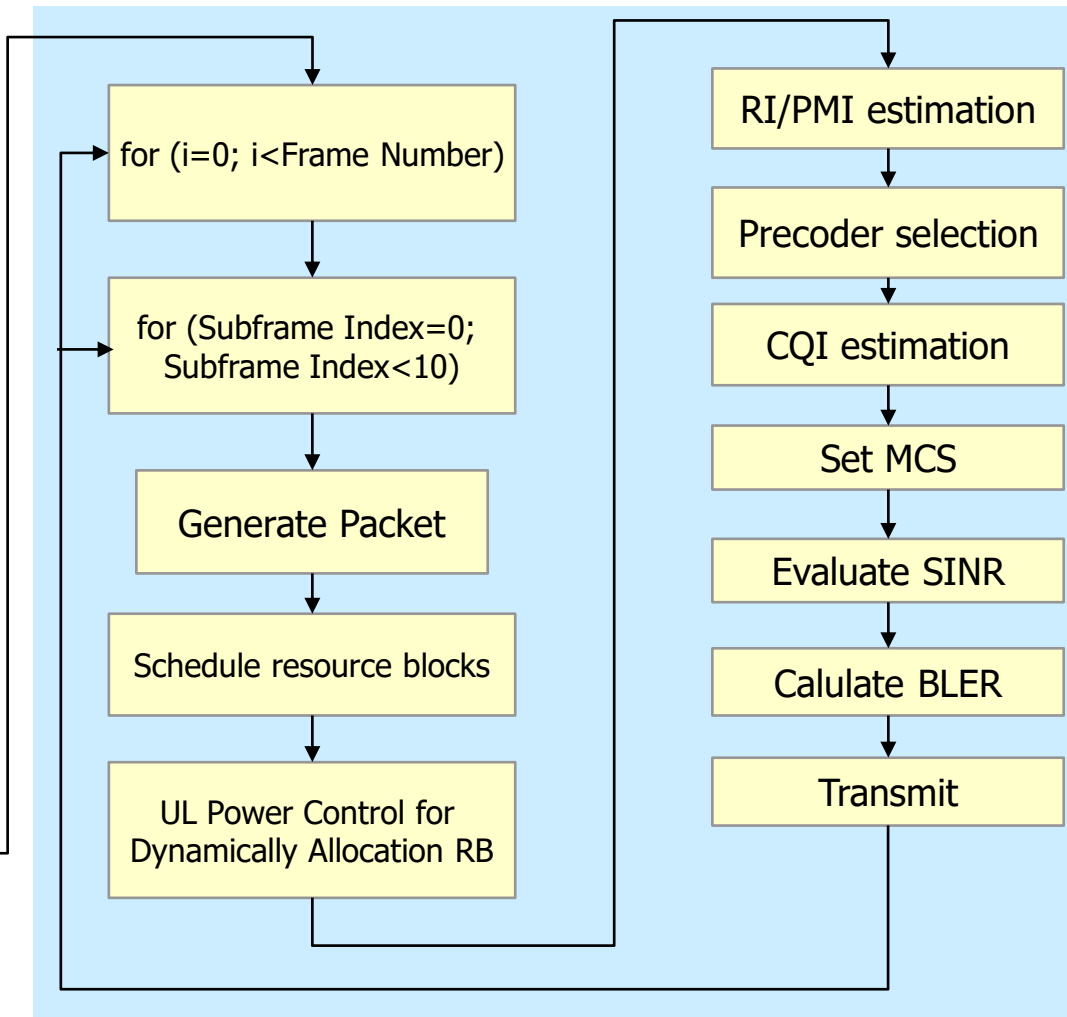
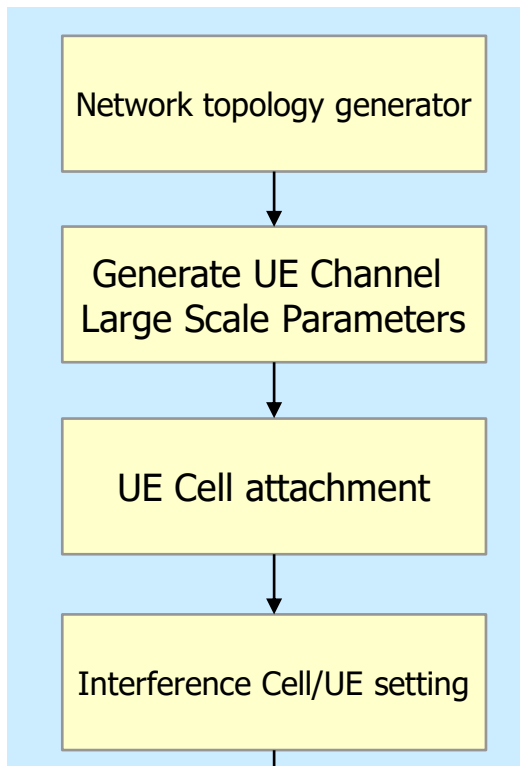
- RLC layer
 - ◆ Traffic model
 - ◆ FTP model
 - ◆ Full buffer model
 - ◆ VoIP model
- MAC layer
 - ◆ Scheduler
 - ◆ HARQ process
- PHY layer
 - ◆ SINR calculator
 - ◆ PHY abstraction



WiSE Program Flow

Run time simulation

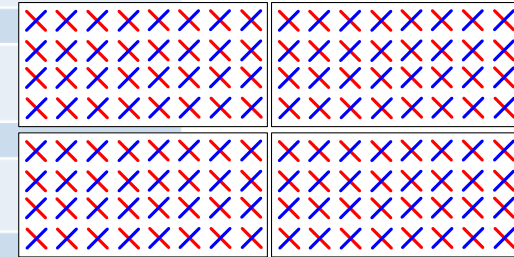
Initialization



Simulation Assumption for dense urban - eMBB

Parameter	Value
Carrier frequency	Macro layer at 30 GHz
BS antenna height	25 m
Total transmit power per TRP	37 dBm for 40 MHz bandwidth
UE power class	23 dBm
Inter-site distance	200 m
TRP antenna elements	256Tx/Rx, $(M, N, P, M_g, N_g) = (4, 8, 2, 2, 2)$, $(d_H, d_V) = (0.5, 0.5)\lambda$. $(d_{g,H}, d_{g,V}) = (4.0, 2.0)\lambda$, $+45^\circ, -45^\circ$ polarization
TRP TXRU configuration	8TXRU, $(M_p, N_p, P, M_g, N_g) = (1, 1, 2, 2, 2)$
UE antenna elements	32Tx/Rx, $(M, N, P, M_g, N_g) = (2, 4, 2, 1, 2)$, $(d_H, d_V) = (0.5, 0.5)\lambda$ $(d_{g,V}, d_{g,H}) = (0, 0)\lambda$. $\Theta_{mg,ng}=90^\circ$; $\Omega_{0,1}=\Omega_{0,0}+180^\circ$; $0^\circ, 90^\circ$ polarization
UE TXRU configuration	4TXRU, $(M_p, N_p, P, M_g, N_g) = (1, 1, 2, 1, 2)$
Antenna element gain	8 dBi for BS; 5 dBi for UE
UE speeds	Indoor users: 3 km/h, Outdoor users (in-car): 30 km/h
Noise figure	7 dB for BS; 10 dB for UE
Traffic model	Full buffer
UE density	10 UEs per TRP
Channel model	UMa_A or UMa_B
TRP boresight	30 / 150 / 270 degrees
Beam set at TRP	Azimuth angle $\phi_i = [-5\pi/16, -3\pi/16, -\pi/16, \pi/16, 3\pi/16, 5\pi/16]$ Zenith angle $\theta_j = [5\pi/8, 7\pi/8]$
Beam set at UE	Azimuth angle $\phi_i = [-3\pi/8, -\pi/8, \pi/8, 3\pi/8]$; Zenith angle $\theta_j = [\pi/4, 3\pi/4]$;
Criteria for analog beam selection for interfering TRP	Random selecting the random beams for non-serving TRP

TRP antenna



UE antenna

