

LTE-U COEXISTENCE

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LTE-U COEXISTENCE TEST SPEC



Channel Selection	Clean Channel Selection	Channel selection avoiding Wi-Fi
	Inter-operator LTE-U	Intra-operator channel selection
Channel Coexistence	Wi-Fi full buffer channel sharing	Equal airtime sharing between LTE-U and Wi-Fi
	Channel sharing with two full buffer Wi-Fi links	Equal airtime sharing between LTE-U and 2 Wi-Fi nodes
	Channel sharing for inter-operator LTE-U and Wi-Fi	Equal airtime sharing between inter-operator LTE-U nodes and Wi-Fi
	Channel sharing between intra-operator LTE-U Nodes	LTE-U channel sharing with efficient reuse of spectrum
Opportunistic SDL	Opportunistic SCell OFF	Ensure LTE-U SCell halts transmissions when not needed

CO-CHANNEL SHARING APPROACH

CHANNEL MONITORING AND TRAFFIC STEERING

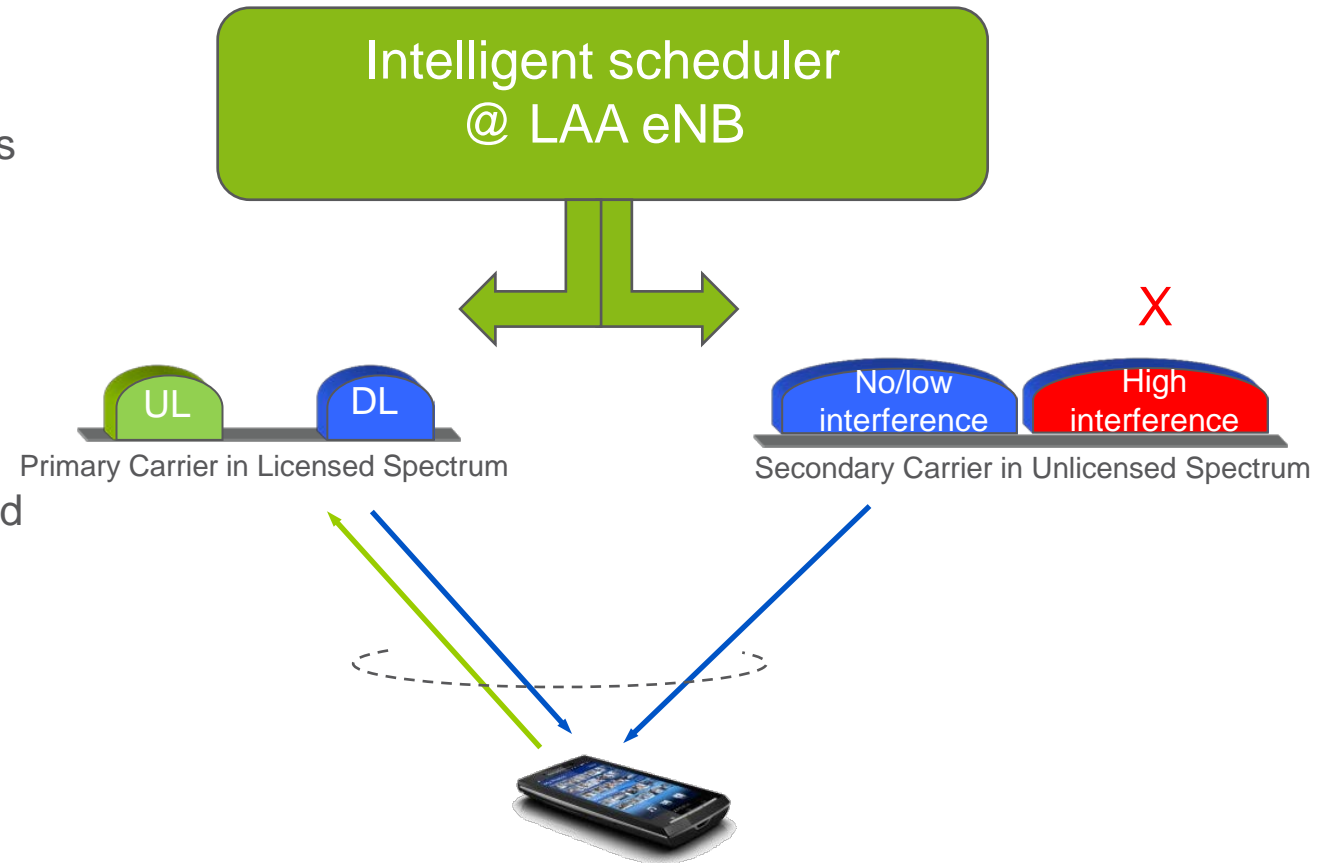


> Channel monitoring

- Measuring channel usage intensity and received power levels
- Rescanning for better channels if channel conditions change

> Intelligent scheduler dynamically steers data between licensed PCell and unlicensed SCells

- Traffic steering based on PCell loads and unlicensed SCell channel conditions
 - > SCell is used on as needed basis

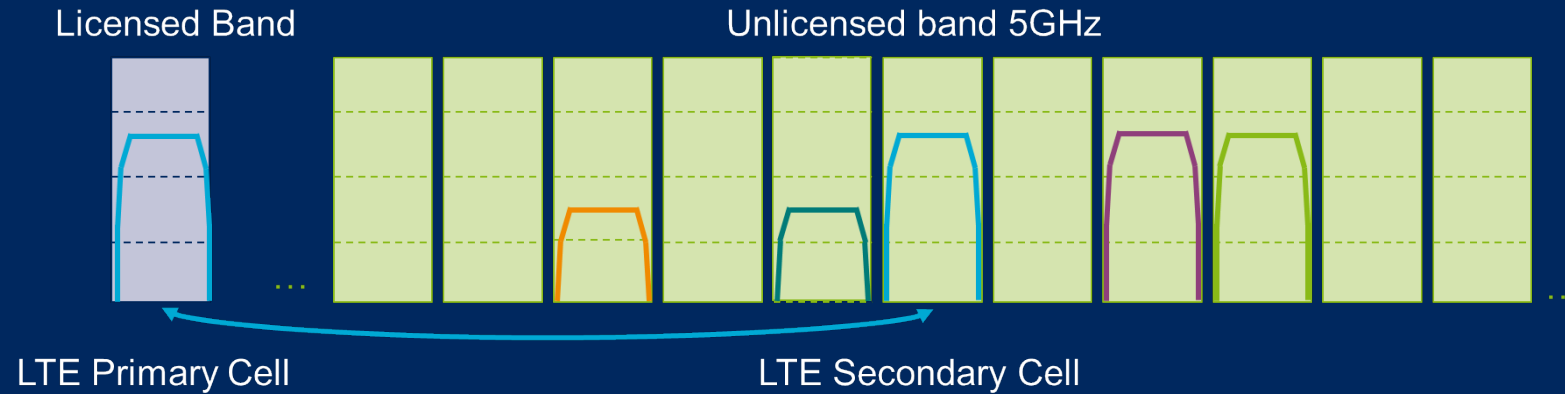


SHARING 5GHZ SPECTRUM



Channel Selection

1



Coexistence using Carrier Sense / Adaptive Transmission (CSAT)

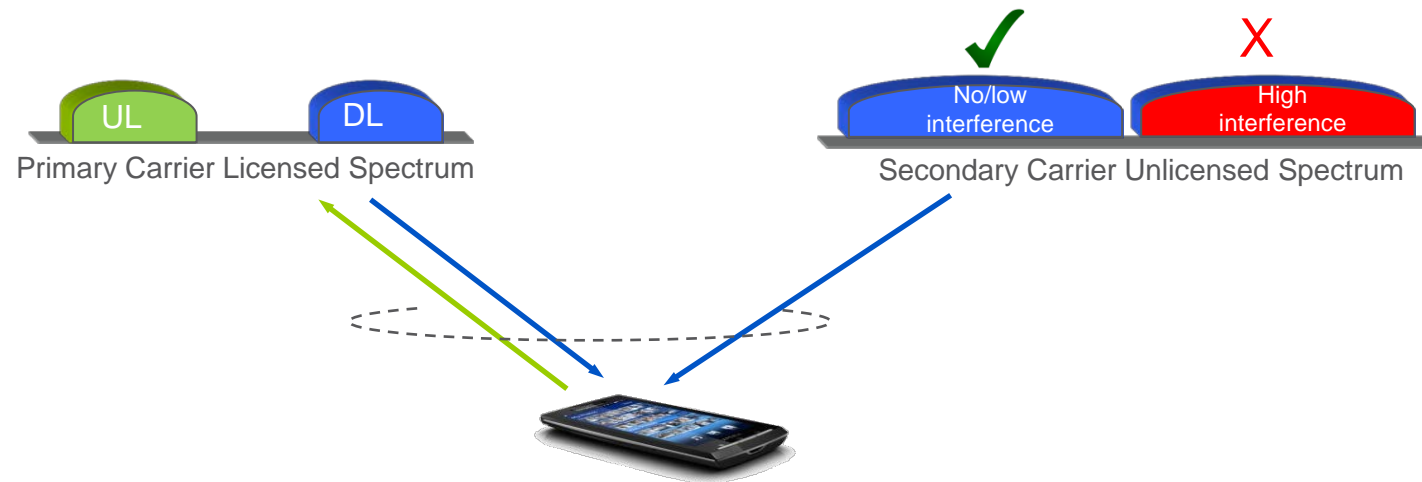
2



LTE-U CHANNEL SELECTION



- › Channel selection performed at startup, periodically & on performance triggers
 - eNB measures received energy/power on each channels
 - eNB Select the channels with lowest measured received energy/power



- During operation eNB continuously monitors the channel performance
- Channel re-selection & re-scan performed when conditions change

LTE-U CHANNEL SELECTION



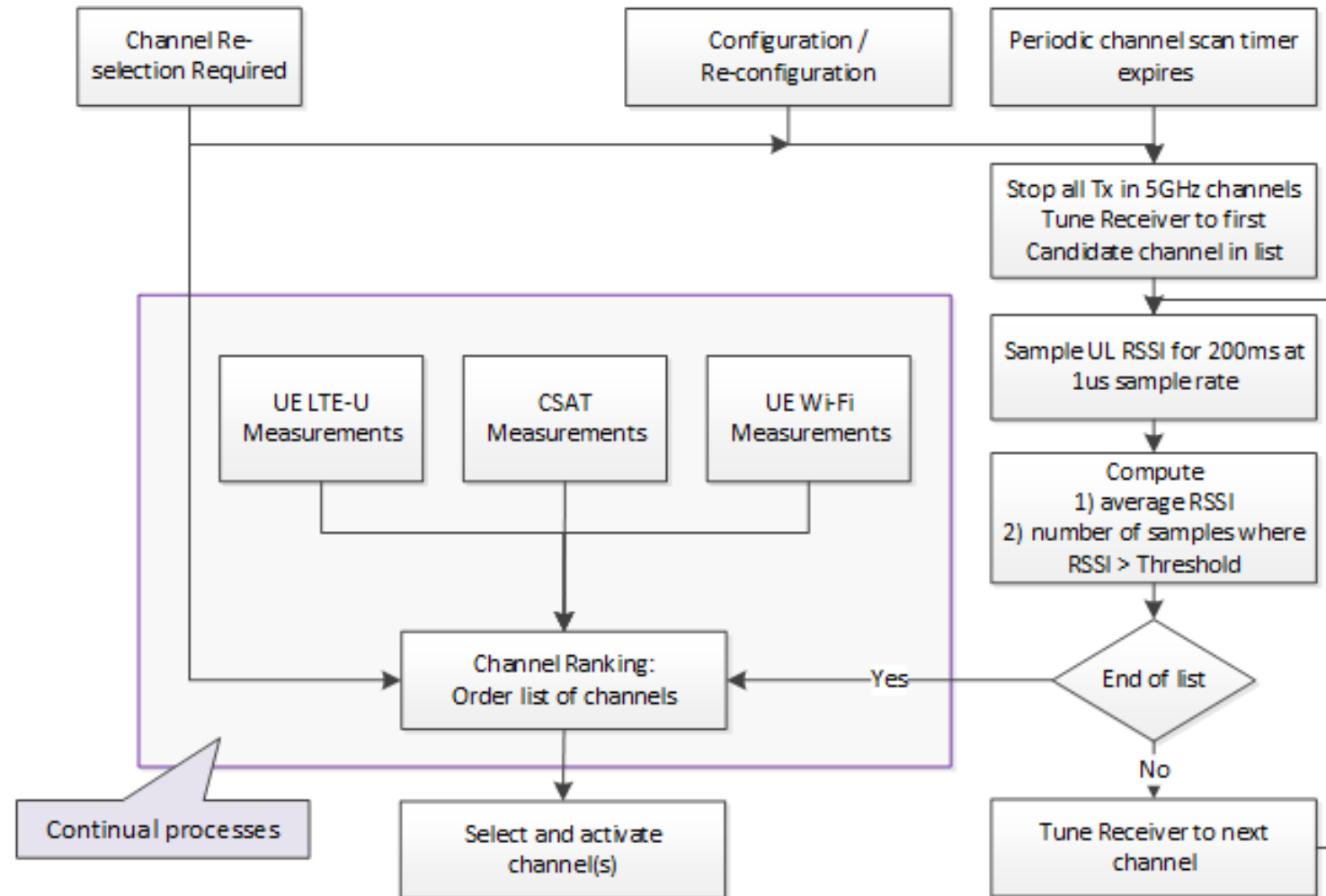
Channel Scan – start-up / periodically

Channel ranking – continual process

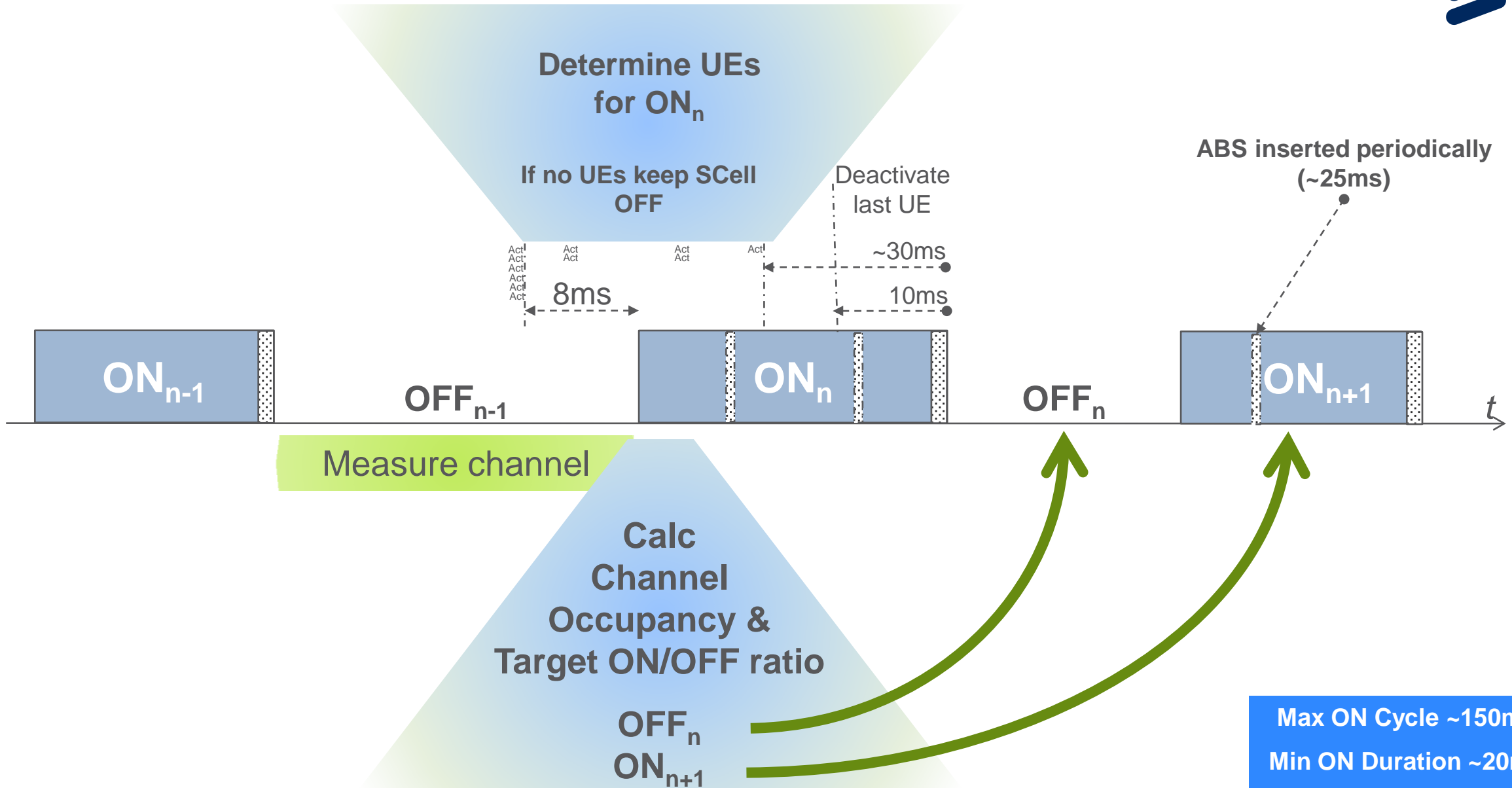
Channel re-selection and full re-scan triggered by performance metrics

Ranking

- › Select cleanest channel
- › Avoid Wi-Fi primary channels
- › Avoid other LTE-U operator channels



CSAT ADAPTIVE ON / OFF

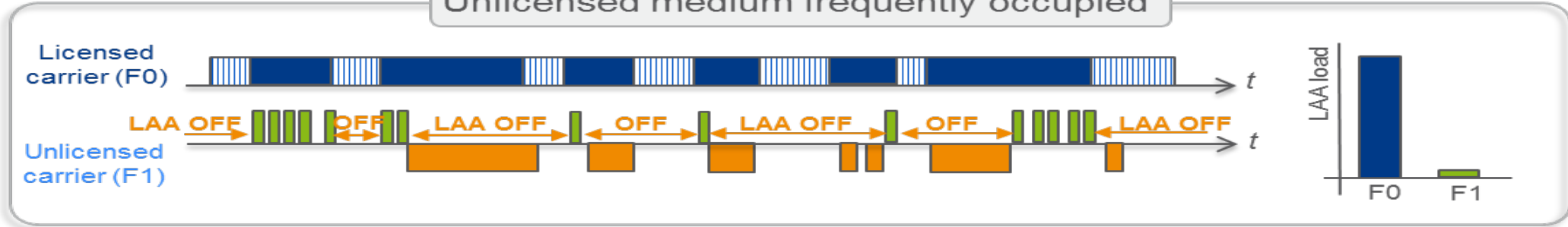


Max ON Cycle ~150ms
Min ON Duration ~20ms
Min OFF Duration ~10ms

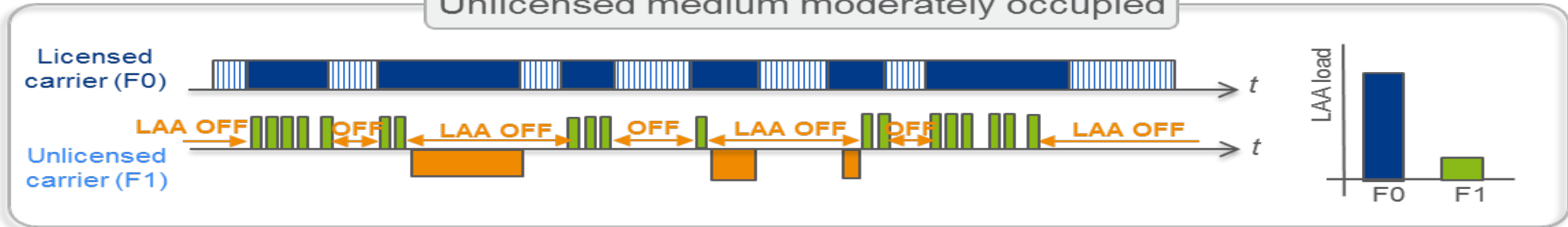
CSAT DUTY CYCLE



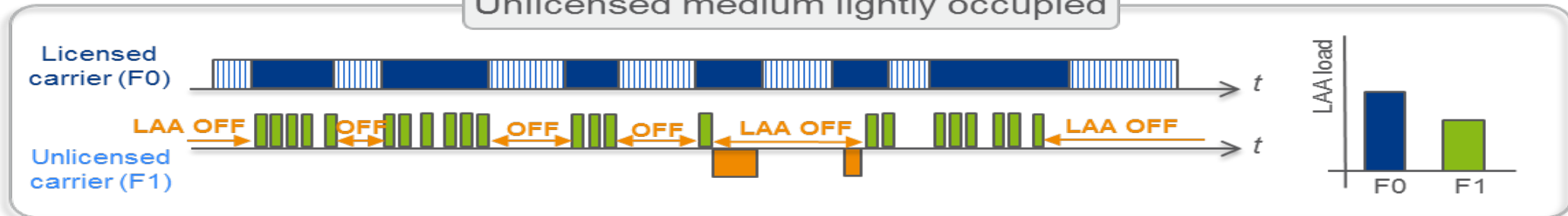
Unlicensed medium frequently occupied



Unlicensed medium moderately occupied

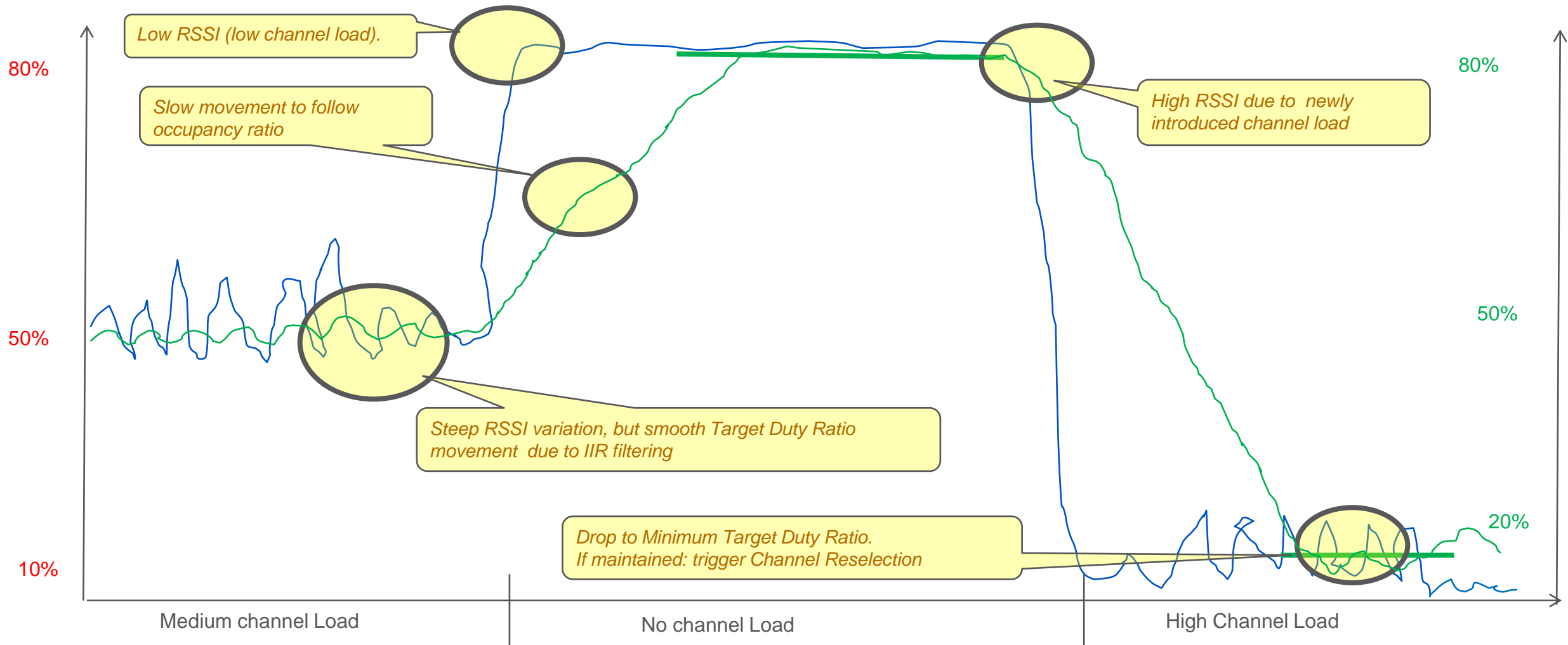


Unlicensed medium lightly occupied



- Unlicensed medium used by LAA
- Unlicensed medium used by other technologies

VARIATION OF TARGET DUTY RATIO



ERICSSON CSAT SUMMARY



	Systems Concepts / Recommendations
ON duration	Variable: 20ms → 150ms
OFF duration	Variable: 10ms → 140ms
Duty Cycle Length	Fixed Duty Cycle
ABS Subframes	Inserted at regular intervals: ~25ms Number of contiguous ABS: 1-3
RSSI / Channel Energy measurements	UL channel energy sampled at 1 μ s intervals
Channel Occupancy algorithm	RSSI threshold count on 1 μ s RSSI samples IIR filter
LTE-U Channel Usage range	0% → 90%
UE Activation Window	Continue to activate UEs up to ~30ms before end of ON period
Early TX termination	When last UE is deactivated within 30ms of the end of the TX ON period, terminate the ON period early
Opportunistic LTE-U SCell OFF	SCell will stay in OFF state when there are no candidate UEs for the SCell

SIMULATION SETUP AND SCENARIOS



- › Objective of simulations
 - Determine LTE-U CSAT co-channel performance and impact to Wi-Fi with different duty cycle lengths and targets
 - Duty-Cycles lengths 50 and 100 ms
 - Various min / max duty-cycles, chosen to ensure a minimum on-period of ~25 ms.

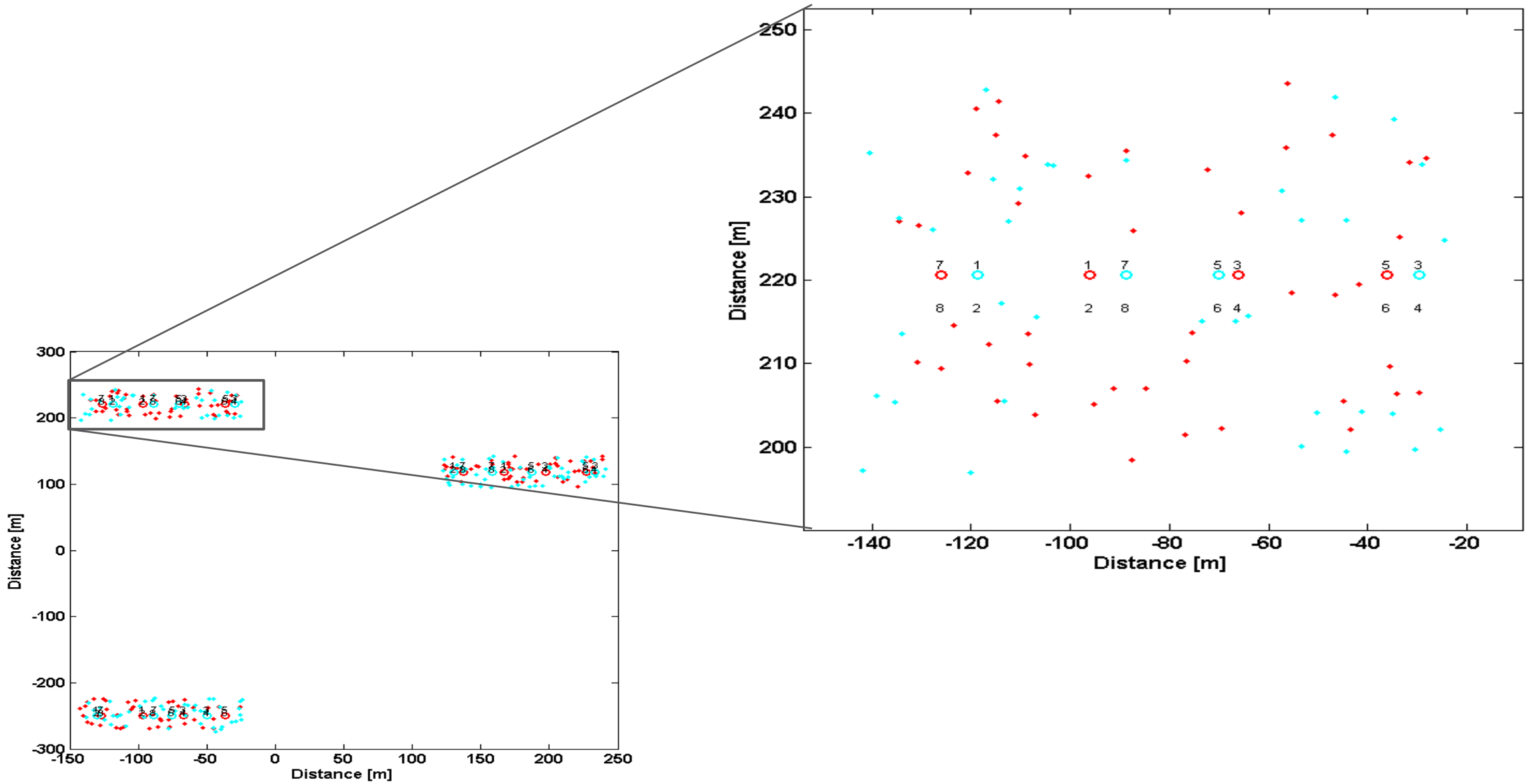
- › AP/User positions are fixed throughout simulation (users randomly placed at start of run)

- › Path loss between all transmitters/receivers calculated using 3GPP methods

- › LTE-U Forum indoor scenarios 9 and 11 used
 - LTE throughput measured across both small cell licensed and unlicensed frequencies (50 MHz)
 - WiFi throughput measured across unlicensed frequencies (40 MHz)
 - Three buildings, two operators
 - 4 APs per operator in each building

- › Traffic model is a modified 3GPP model, fixed file size of 500 kB arrives with a Poisson distribution. Reading time is varied to simulate different load conditions.

AP/UE MAP

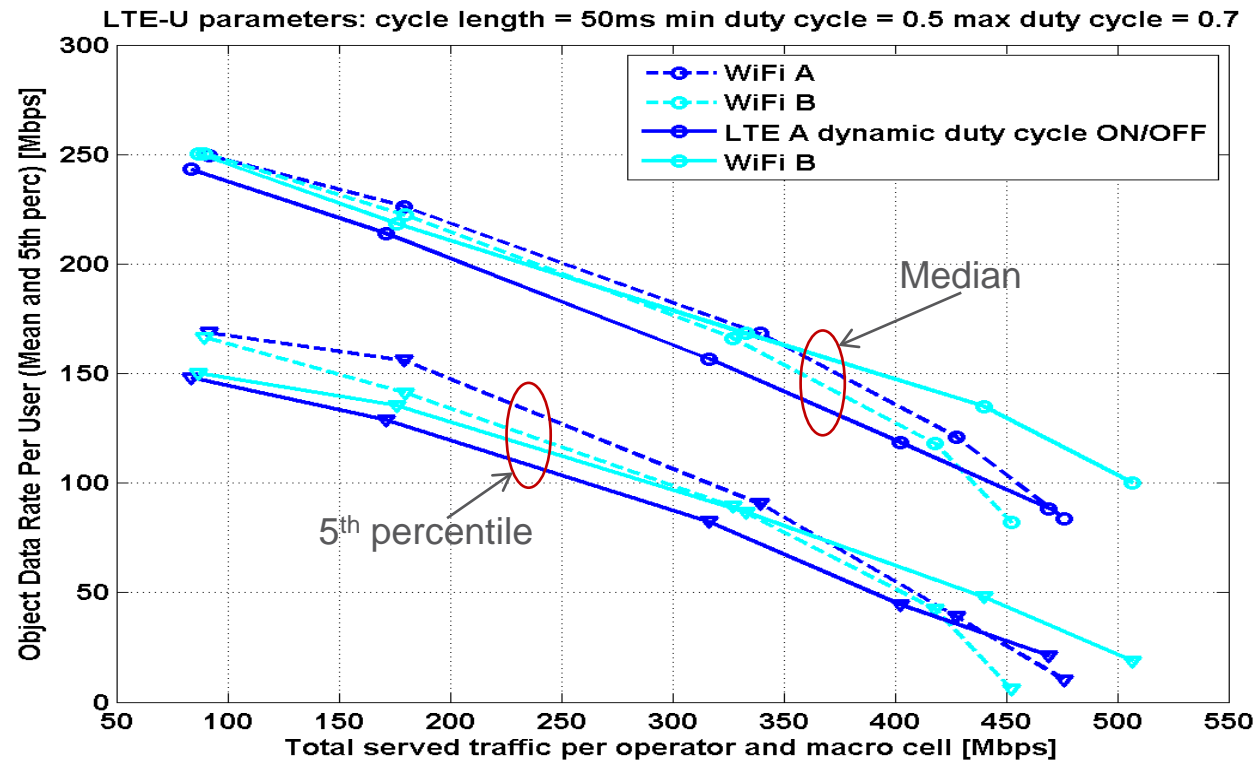


CSAT & WIFI PERFORMANCE

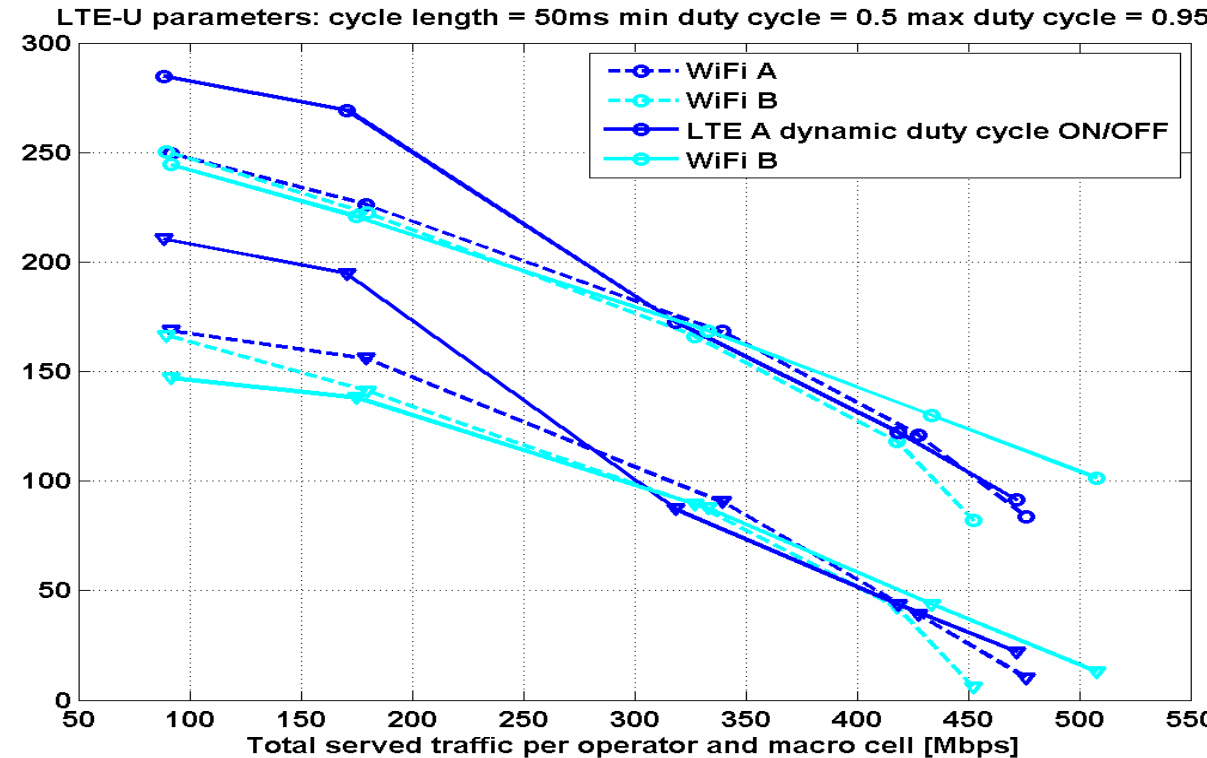
50_{MS} DUTY CYCLE



Compare Wi-Fi and LTE-U throughput using a 50ms Duty Cycle with 70% and 95% maximum usage targets



50ms Duty Cycle 50% → 70% usage targets



50ms Duty Cycle 50% → 95% usage targets

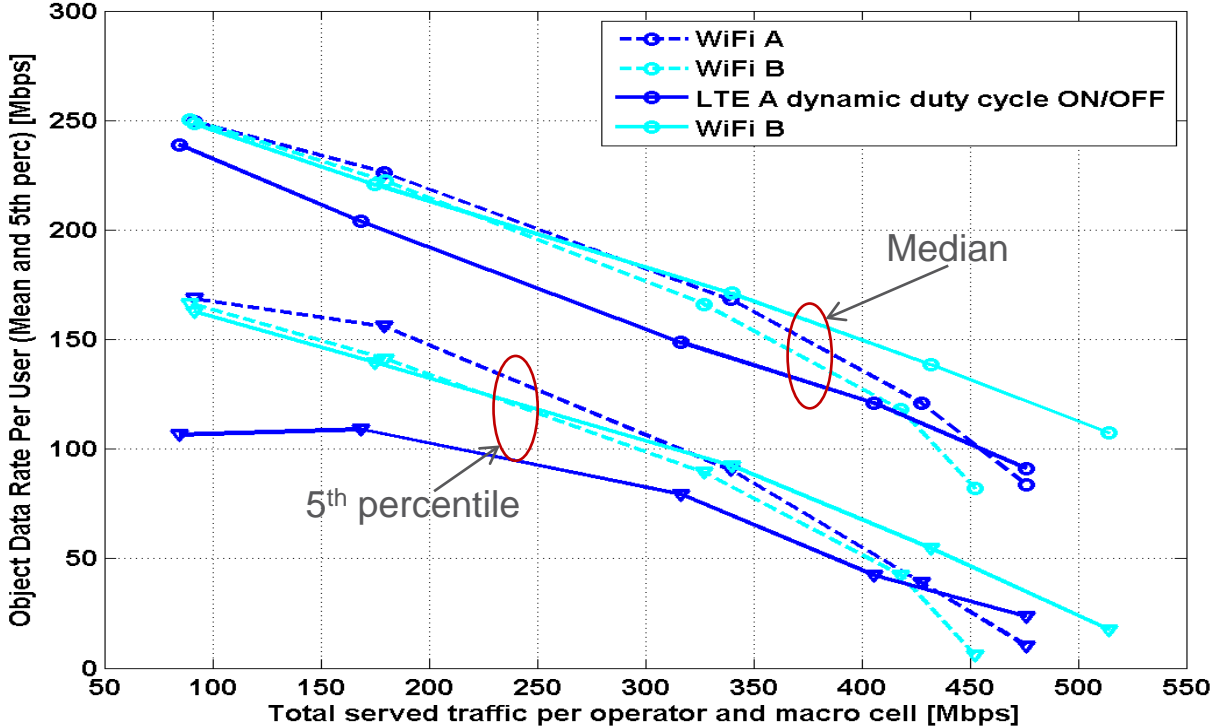
CSAT & WIFI PERFORMANCE

100_{MS} DUTY CYCLE



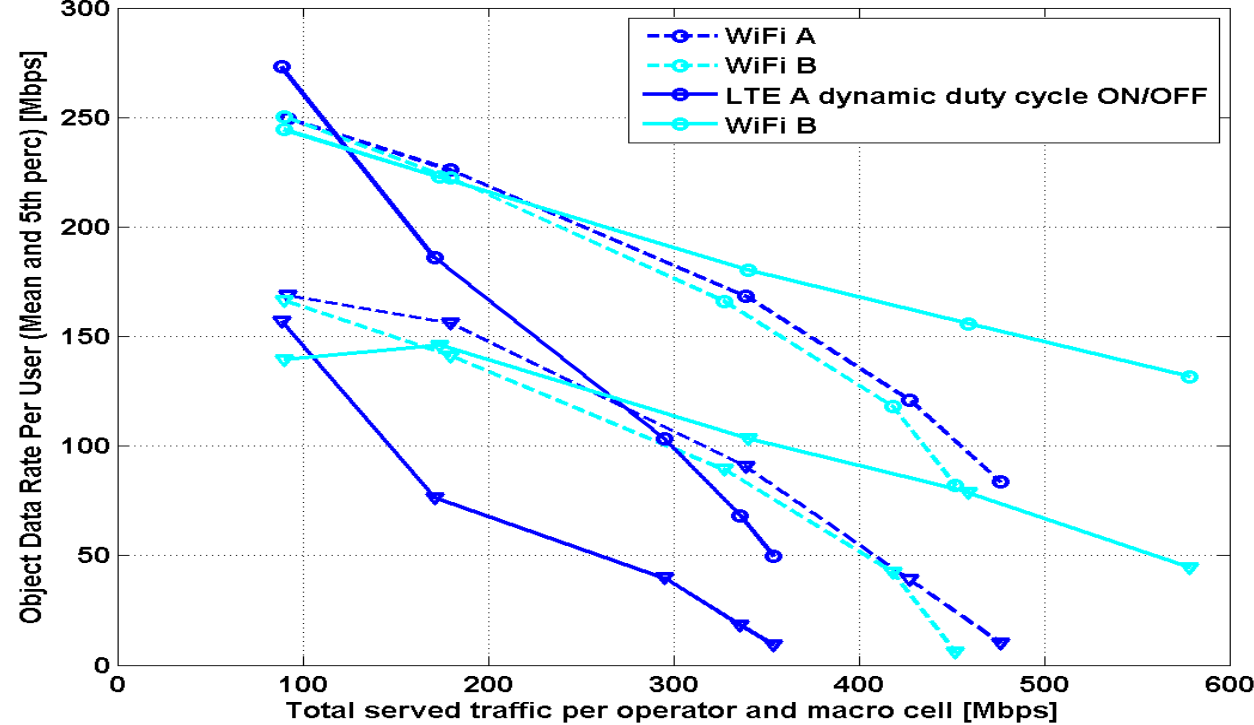
Compare Wi-Fi and LTE-U throughput using a 100ms Duty Cycle with 70% and 95% maximum usage targets

LTE-U parameters: cycle length = 100ms min duty cycle = 0.5 max duty cycle = 0.7



100ms Duty Cycle 50% → 70% usage targets

LTE-U parameters: cycle length = 100ms min duty cycle = 0.3 max duty cycle = 0.95

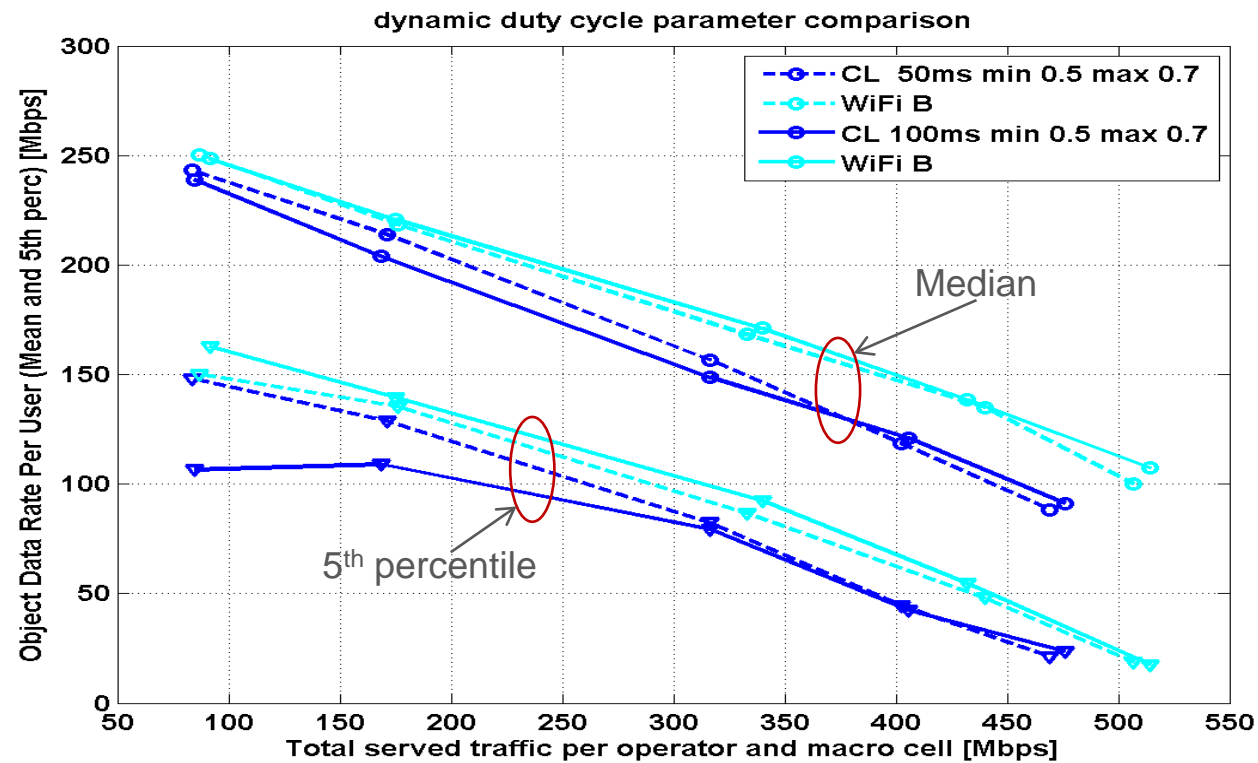


100ms Duty Cycle 30% → 95% usage targets

DUTY CYCLE LENGTH COMPARISON



Compare Wi-Fi and LTE-U throughput using 50ms or 100ms Duty Cycle





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