



SEMAFOUR

Performance of WLAN RSS-based SON for LTE/WLAN access network selection

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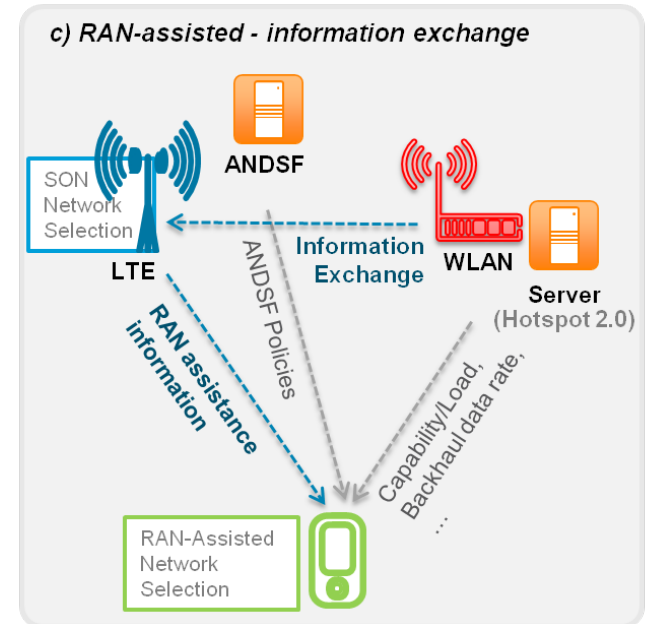
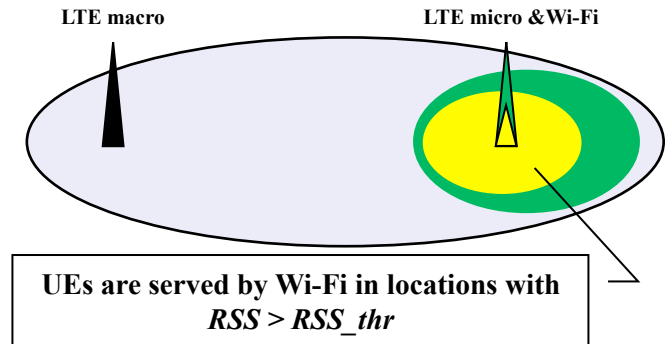
- **Why SON for LTE/WLAN access selection** - Motivation
- **What is it** – Access selection rule and SON function
- **If it works** – Simulation results in a heterogeneous network scenario
- **How does it work** – Load balancing leading to user throughput improvement
- **If it really works** – Various traffic model parameters
- **How dose it work in practice** – Implementation issues
- **How to make it better** – Summary and future work

Why SON for LTE/WLAN Access Selection?

- Operators are using WLAN for offloading
 - “Carrier grade Wi-Fi”
- Great interests in integrating cellular and WLAN networks
- One of the key technology component: **access selection** / traffic steering
- SON for access selection
 - SON: proved working in related areas, e.g. load balancing
 - A good candidate to address the LTE/WLAN access selection
- Task: design a SON function and prove if it works (or not) by simulation

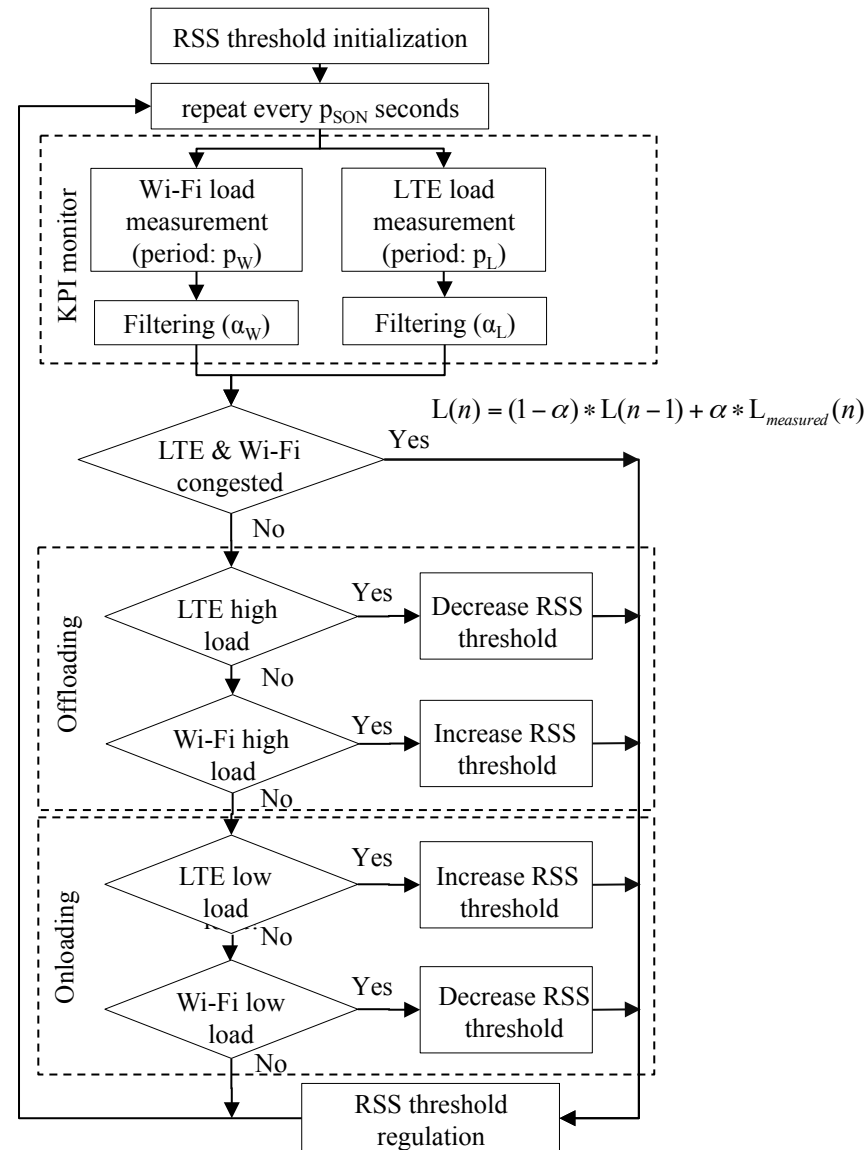
What Is It – Control Parameters and Monitoring KPIs

- Control parameter
 - Wi-Fi RSS admission threshold
- RSS-based access selection rule
 - Connect to WLAN if $RSS > RSS_Thr$
 - Access selection at session start
- Monitoring KPIs
 - LTE: PRB utilization percentage
 - Wi-Fi: Channel busyness percentage
 - Busy: at least one node is transmitting or attempts to transmit
 - Limitation: may not reflect load especially with full buffer users
 - Not comparable between them



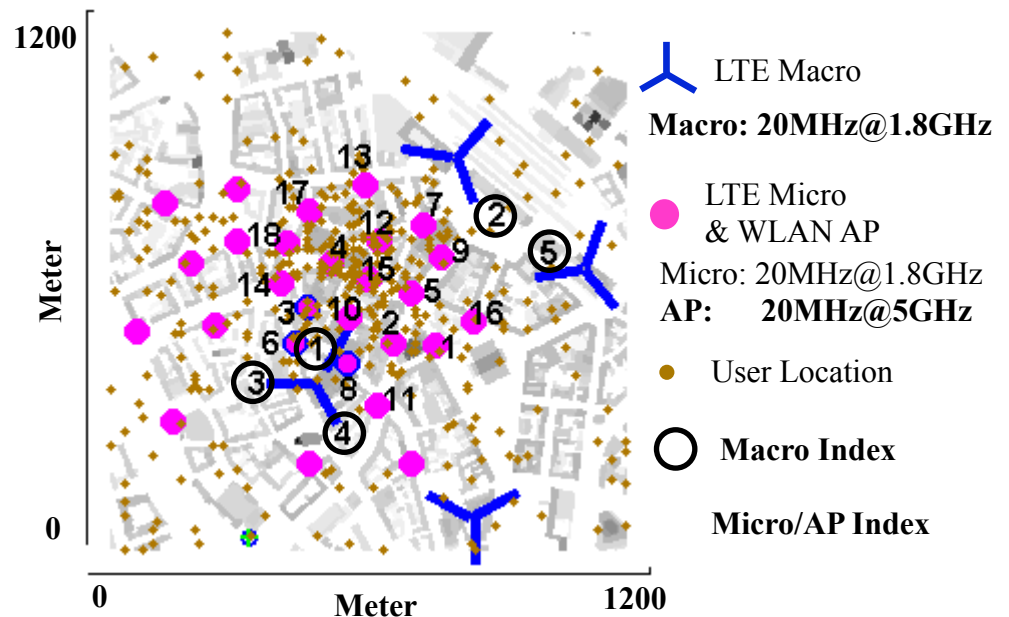
What Is It – SON Algorithm

- SON function
 - Overload protection
 - Offloading
 - Onloading
- Important parameters
 - Filtering factor
 - SON update period and step size
 - Congestion/High/low load thresholds
- Operator policy fulfillment
 - Utilize LTE network until highly loaded
 - **Balanced LTE/WLAN user throughput**



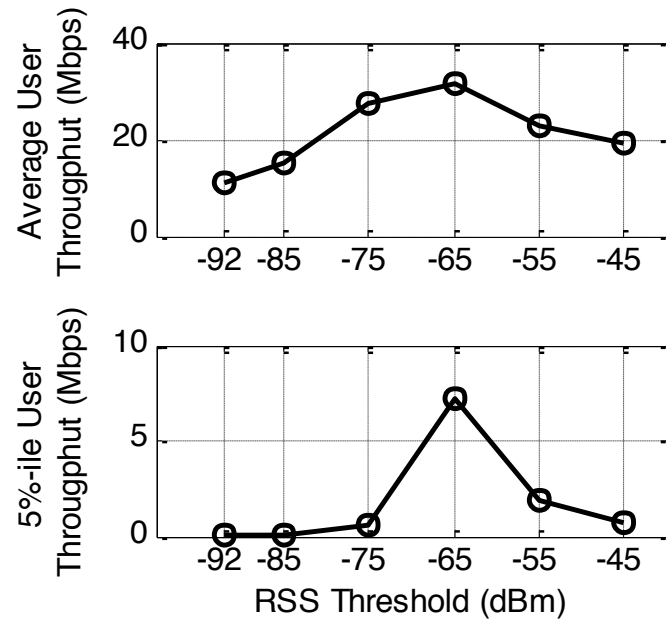
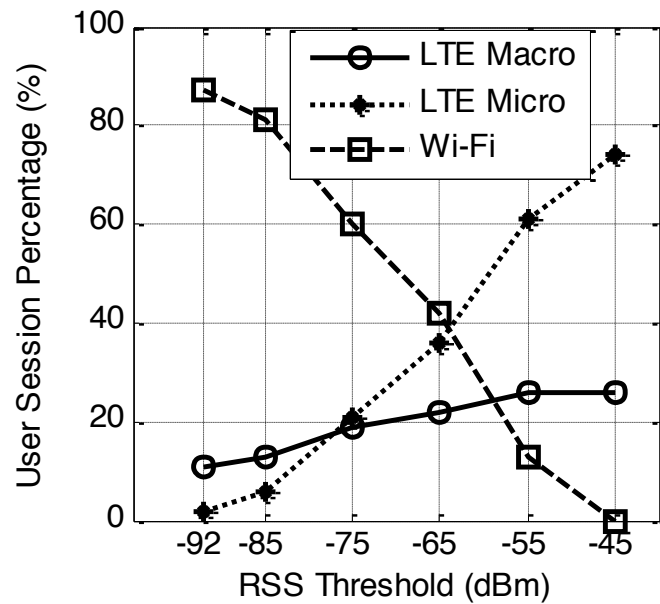
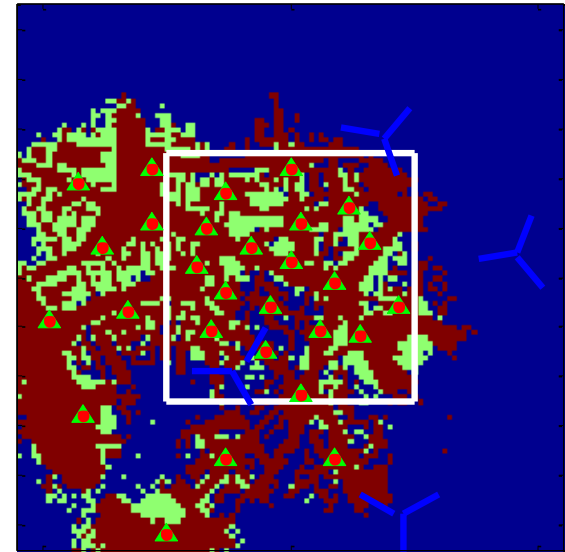
If It Works – Simulation Scenario

- Environment: 1.1 km² urban area located in city center of Hannover
- Deployment: 5 LTE Macros (46 dBm), 28 co-located outdoor LTE Micro (33 dBm) / AP (20 dBm)
- 6 dB cell extension offset for Micros
- Spatial traffic distribution: Outdoor busy hour traffic + a hotspot with 70% traffic outdoor
- Offered traffic: Fixed size UDP downloading / uploading (DL: 5 MB; UL: 0.8 MB; 12 arrival/sec)
- Indoor users are located on the ground floor only
- No external interference
- Mobility: Stationary users only



If It Works – Fixed RSS Threshold

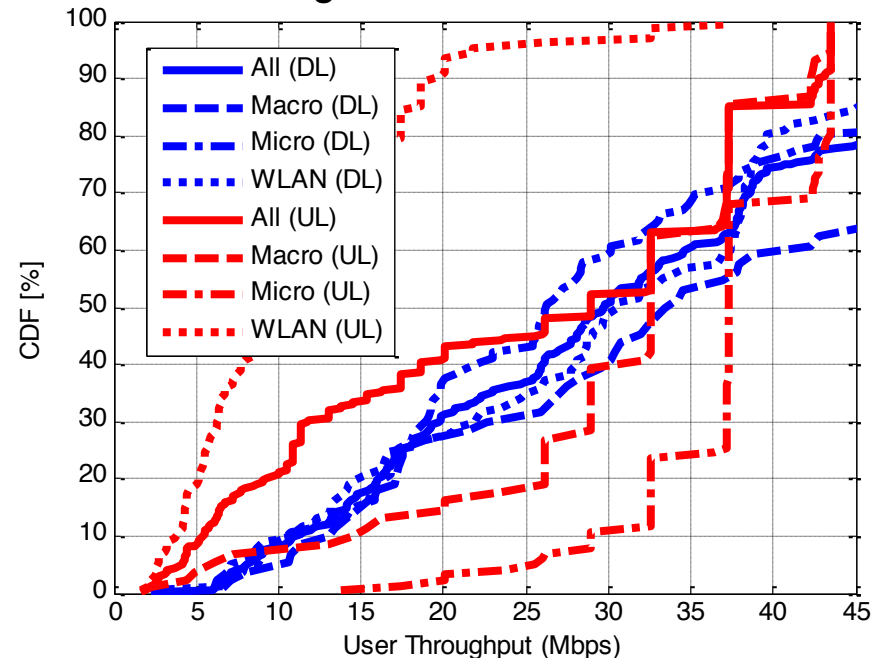
- Highest average and 5th percentile user throughput
 - Fixed RSS threshold = -65 dBm.
 - User session split:
 - WLAN: 42%
 - LTE Micro: 37%
 - LTE Macro: 21%



If It Works – SON Function to Improve User Throughput

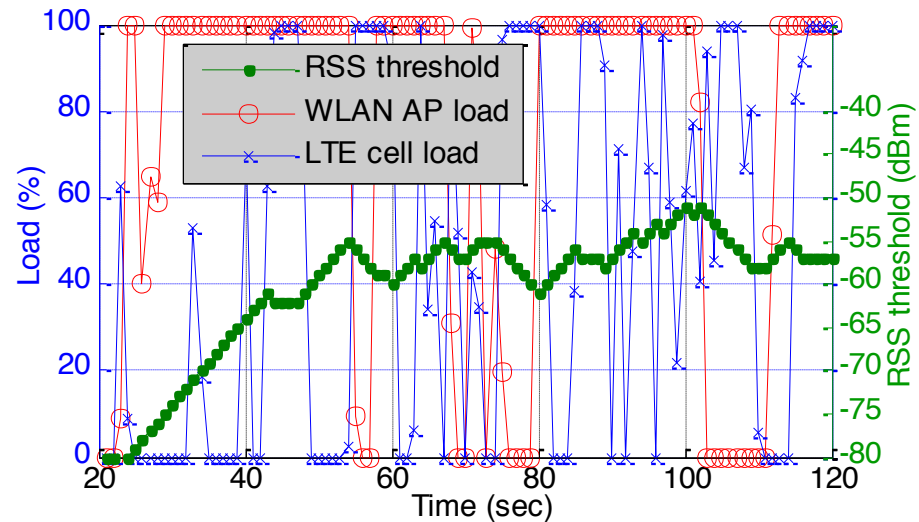
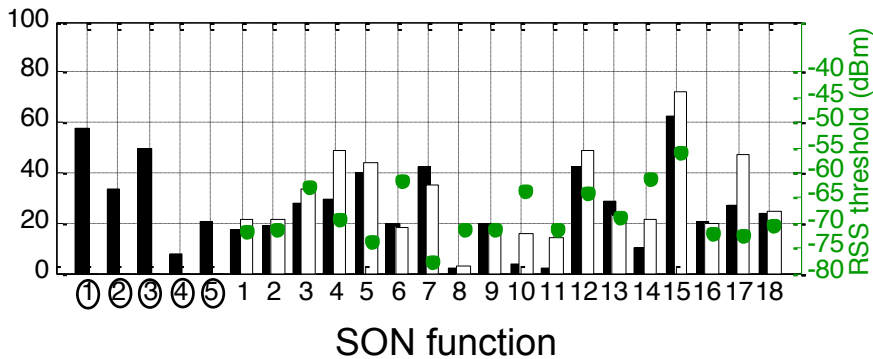
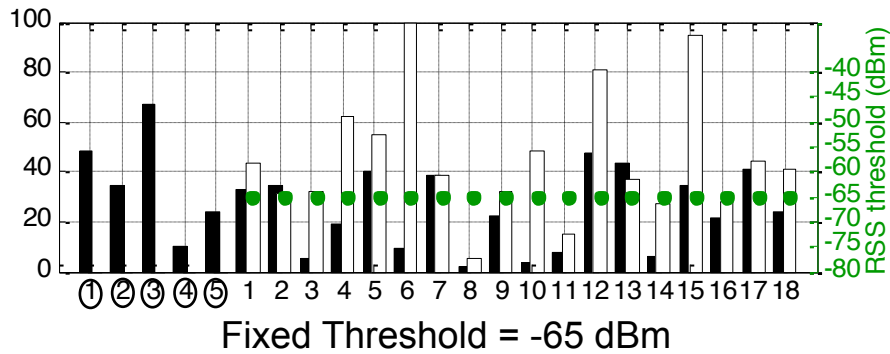
- 14% gain in 5th percentile user throughput comparing to the best fixed threshold reference case
- Sensitivity to SON parameter configuration
 - Not very sensitive to the load filtering factor
 - Need to be fast enough to capture traffic load variation
- Balanced DL user throughput among users
- UL user throughput is not optimized with the DL KPI driven algorithm

	5%-ile / Avg. user thrp. (Mbps)	WLAN users (%)
Reference: WLAN if coverage Fixed RSS Thr = -92 dBm	0.1 / 11	87
Reference: Best Fixed Threshold Fixed RSS Thr = -65 dBm	7.2 / 31.6	42
SON: reference settings $P_{SON}/P_L/P_W=1s$, RSS Thr Step=1dB, $\alpha=0.9$	8.2 / 31.7	41
SON: smooth load filtering $P_{SON}/P_L/P_W=1s$, RSS Thr Step=1dB, $\alpha=0.5$	7.5 / 33.1	45
SON: slow RSS_Thr update $P_{SON}/P_L/P_W=2s$, RSS_Thr_Step=0.5dB, $\alpha=0.9$	3.7 / 28.2	54
SON: fast RSS_Thr update $P_{SON}/P_L/P_W=0.5s$, RSS_Thr_Step=2dB, $\alpha=0.9$	7.1 / 31.2	38



How Does It Work – Load Balancing

- A more balanced load between the two system
 - Load was kept in the configured range by the SON function
- Convergence of the RSS threshold
 - ‘Warming-up’ and stabilization



If It Really Works – Various Traffic Parameters

- **Smaller file size and higher user arrival rate:** More simultaneously active users → Lower WLAN efficiency and higher WLAN load → SON moves more users to LTE
- **Larger file size and lower user arrival rate:** Approaching to full buffer traffic → Resource utilization is not a good load measure
- **Lower offered traffic:** SON outperforms the fixed RSS threshold in the 5th percentile user throughput

[File size: DL/UL, User arrival rate]	SON with the reference settings		RSS_Thr = -65 dBm	
	5%-ile / Avg. user thrp. (Mbps)	WLAN users (%)	5%-ile / Avg. user thrp. (Mbps)	WLAN users (%)
Reference [5 MB/0.8 MB, 12]	8.2/31.7	41	7.2/31.6	42
[2.5 MB/0.4 MB, 24]	7.2/27.8	39	6.6/26.8	42
[1.25 MB/0.2 MB, 48]	5.8/23.1	34	3.9/21.8	42
[10 MB/1.6 MB, 6]	6.6/33.0	40	7.2/35.6	42
[5 MB/0.8 MB, 6]	10.7/38.1	48	8.3/40.1	42

- The RSS-based SON algorithm is primarily a distributed solution because it may be difficult for the central controller, e.g. ANDSF, to execute an algorithm which updates parameters every few seconds.
- Implementation of the RSS-based access selection rule
 - Executed in terminals:
 - RSS_Thr is send to terminals via broadcasted or dedicated signalling channels being standardized in 3GPP
 - Executed in network:
 - Uplink RSS is monitored at the network node and the node controls the access selection
- Information exchange between LTE and WLAN
 - Standardization of such an interface is being discussed in 3GPP
 - Proprietary interfaces
 - Terminals as relays
- WLAN RSS measures
 - RSSI: Received Signal Strength Indicator
 - RCPI: Received Channel Power Indicator

- Simulation results showed a RSS-based SON algorithm for access network selection between the LTE and WLAN systems successfully
 - Balanced the load between the two systems
 - Optimized user throughput statistics with various traffic parameter settings.
- Future work
 - The optimization of the SON parameters with respect to the traffic parameters is subject to further study.
 - Better load measure
 - Evaluate the SON function in more dynamic scenarios: mobility and and/or mixed traffic types.
 - More understanding of the coexistence of distributed and centralized SON functions is needed to achieve a holistic solution and further optimize the performance.