CREW

Cognitive Radio Experimentation World

Wi-Fi conferencing optimization: Efficient experiment parameter screening [Arizona State University]

Problem

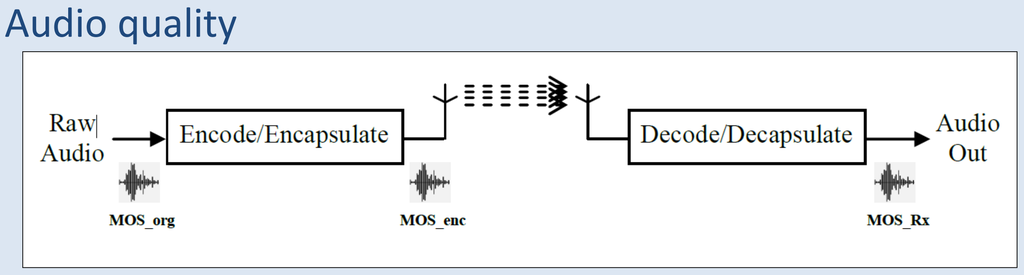
- Wireless systems usually have a large number of design parameters (Factors) all of which influence the systems behavior.
- Which combinations of these factors has the largest influence on the system behavior?

Goal

- Identify optimum settings of a Wi-Fi conferencing scenario with 24 configurable parameters (5.5 x 10^{12} combinations).
- Analyzing system behavior, parameter sensitivity and factor interaction through step by step screening of the design parameters.

Experiment scenario

- Wi-Fi conferencing scenarios emulated in the w-iLab.t testbed
  - Wi-Fi speaker transmits audio to 40 listener nodes for 120sec. (IP/UDP/RTP/audio)
- 2 performance metrics are evaluated
  - Audio quality



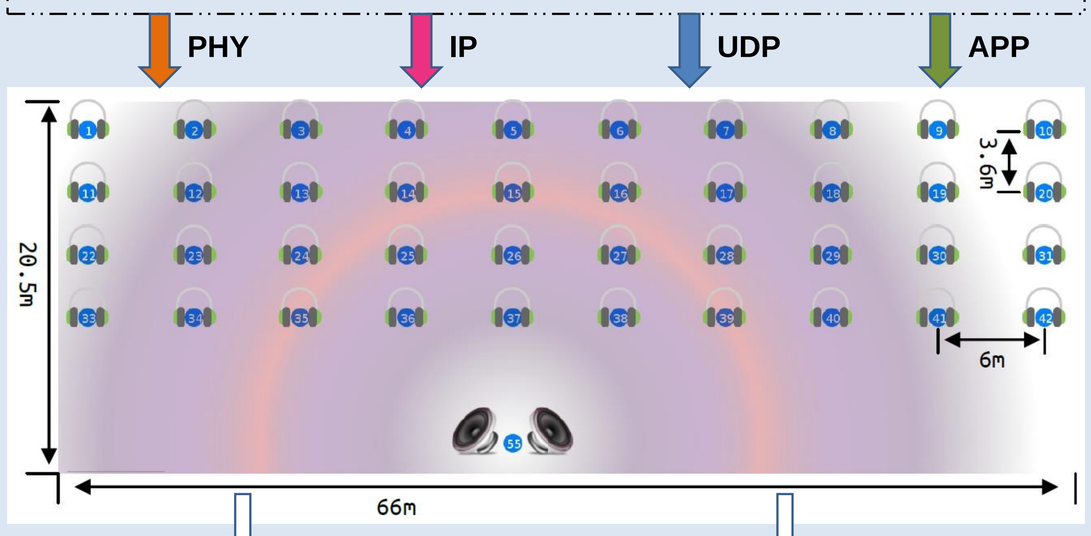
  - Generated transmission exposure

$$EI^{SAR} = \frac{1}{T} \sum_{t,p,e,r,c,l,pos}^{N_T,N_p,N_E,N_R,N_C,N_L,N_{pos}} f_{t,p,e,r,l,c,pos} \left[\sum_{u}^{N_U} \left(d^{UL} \overline{P}_{TX} \right) + d^{DL} \overline{S}_{\text{inc}} \right] \left[\frac{W}{kg} \right]$$

- Both metrics are influenced by the 24 design parameters

Design Parameters

Band, Channel, Rate, Tx-Power, MTU, Tx-QueueLen, Q-Disc, IP-Frag_Low_Thresh, IP-Frag_High_Thresh, UDP_RMem_Min, RMem_Default, RMem_Max, WMem_Default, WMem_Max, UDP_Mem_Min, UDP_Mem_pressure, UDP_Mem_Max, ROHC, Codec, Codec_BitRate, FrameLength_Aggregation, Interference_COR, Background_Sensing



Audio Quality

Electromagnetic Exposure

Locating Array

- A locating array identifies the settings in which significant t-way interactions are covered
  - Experiment analysis of 1-way (main interactions) and 2-way factor interactions
  - The number d of t-way interactions must be known a priori to construct the array, but analysis can be applied iteratively
- Total number of experiments (with 24 factors)
  = 6*5*5*5*5*3*4*5*3*4*4*3*5*4*3*5*4*2*4*3*3*2
  = **5.59872×10^{12} experiments**
  = 20 M years (if 2 min. / experiment)
- Locating Array experiment
  = 109 experiments
  = less then 4 hours

Preliminary Results

- Audio Quality & latency show normal distributions, but not the jitter
- Each objective is sensitive to different parameters
  - MOS objective is most sensitive to Codec Bitrate.
  - Latency is most sensitive to the interference.
  - Specific parameter combinations can have a high impact due to 2-way interactions
  - E.g. qdisc=pfo fast udp wmem min=0.1

Weight	Factor/Interaction
-2.3577	codecBitrate=7600/7750
0.97804	codec=opus × codecBitrate=16800
0.58577	udp_rmem_min=0.019231 × udp_mem_max=949
-0.54886	qdisc=pfifo_fast × udp_wmem_min=0.1
-0.50473	udp_wmem_min=0.5 × codec=opus
-0.49794	codecBitrate=16800
-0.48517	wmem_default=0.25 × sensing=1
-0.47448	mtu=1280 × codec=opus
0.4075	ipfrag_high_thresh=4194304 × codec=speex
-0.39433	band=2.4 × interferenceChannelOccupancy=0.9

Example outcome table: top 10 interactions affecting aggregate MOS score

Testimony

- This was a perfect opportunity to get real data from real testbeds, resulting from lots of parameter combinations.
- There was a very good collaboration with the CREW partners during the experiment.

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PROJECT DATA

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