Midterm & Homework #5

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Midterm Grades

- 平均=82.69
- 標準差=17.71

HW#5 Mini-Porject

Read Magazine Articles

- Due Date: 2024/12/23

- Find at least two IEEE magazine articles related to wireless and mobile networking.
  - Please find articles published in recent years (2020~now and early access articles). Write the report after reading those articles.
    - https://ieeexplore.ieee.org/Xplore/dynhome.jsp

- Write report to summarize and discuss the technologies covered in the article

Report: Summary

- [1] Summarize the articles
  - what is the problem
  - what is the importance
  - what is the proposed solution
  - what is the contribution of the article
-
- [2] Strengths and weaknesses of the described technologies
  - what is good
  - what is bad

Report: Discussions

- [3] Compare/classify the described technologies. You could also compare it to the state-of-the art.

- [4] Your comments and future direction

Bonus

- Extended survey
  - [Optional] Do a quick search and mini-survey to find out more related research papers/researchers. What do you find? What's useful or interesting?

Report format

- Please include those articles in the reference section of your report (you could refer to the citation format in the article you read)
- [Optional] You are encouraged to use IEEE paper format to write the report

Resources

- S. Keshev, “How to Read a Paper“
  - https://dl.acm.org/doi/pdf/10.1145/1273445.1273458

IEEE Magazines

- IEEE Communications Magazine
  - https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=35
- IEEE Wireless Communications
  - https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=7742
- IEEE Network
  - https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=65
- IEEE Communications Standards Magazine
  - https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=7886829

IEEE Magazines

- IEEE Vehicular Technology Magazine
  - https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=10209

- IEEE Internet of Things Magazine
  - https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=8548628

Sample Topics

Time-Sensitive Wi-Fi

- "Toward the Internet of Medical Things for Real-Time Health Monitoring Over Wi-Fi," IEEE Network 2024
  - https://ieeexplore.ieee.org/document/10388245
- "Controlled Channel Access for IEEE 802.11-Based Wireless TSN Networks," IEEE Internet of Things Magazine 2023
  - https://ieeexplore.ieee.org/document/10070404
- "WiFi TSN: Enabling Deterministic Wireless Connectivity over 802.11," IEEE Communications Standards Magazine 2022
  - https://ieeexplore.ieee.org/document/10034532

Machine Learning and 6G

- "Toward Reinforcement-Learning-Based Intelligent Network Control in 6G Networks," IEEE Network 2024
  - https://ieeexplore.ieee.org/document/10293205
- "On Combining XAI and LLMs for Trustworthy Zero-Touch Network and Service Management in 6G," IEEE Communications Magazine (Early Access)
  - https://ieeexplore.ieee.org/document/10742571
- "Machine Learning-Based Channel Quality Prediction in 6G Mobile Networks," IEEE Communications Magazine 2023
  - https://ieeexplore.ieee.org/document/10192311

Edge Computing and Wireless System

- "Integrating Satellites and Mobile Edge Computing for 6G Wide-Area Edge Intelligence: Minimal Structures and Systematic Thinking, " IEEE Network 2023
  - https://ieeexplore.ieee.org/document/10239284
- "Learning IoV in 6G: Intelligent Edge Computing for Internet of Vehicles in 6G Wireless Communications," IEEE Wireless Communications 2023
  - https://ieeexplore.ieee.org/document/10061645
- "Collaboration of Heterogeneous Edge Computing Paradigms: How to Fill the Gap Between Theory and Practice," IEEE Wireless Communications 2024
  - https://ieeexplore.ieee.org/document/10091816

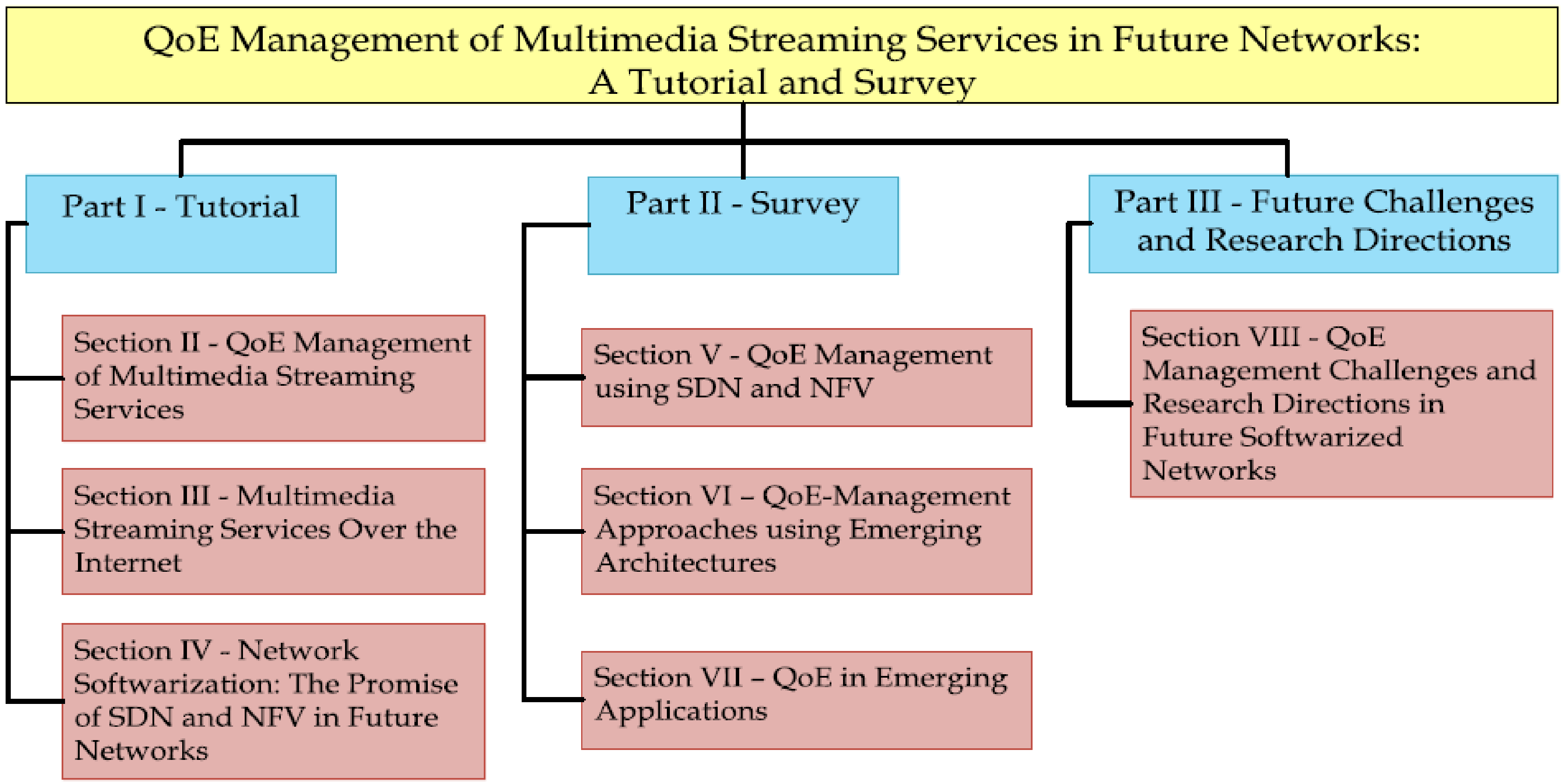
Integrated Sensing and Communications

- "Integrated Sensing and Communication for 6G: Ten Key Machine Learning Roles," IEEE Communications Magazine 2023
  - https://ieeexplore.ieee.org/document/10049816

- "AI-Enhanced Integrated Sensing and Communications: Advancements, Challenges, and Prospects," IEEE Communications Magazine 2024
  - https://ieeexplore.ieee.org/document/10663823

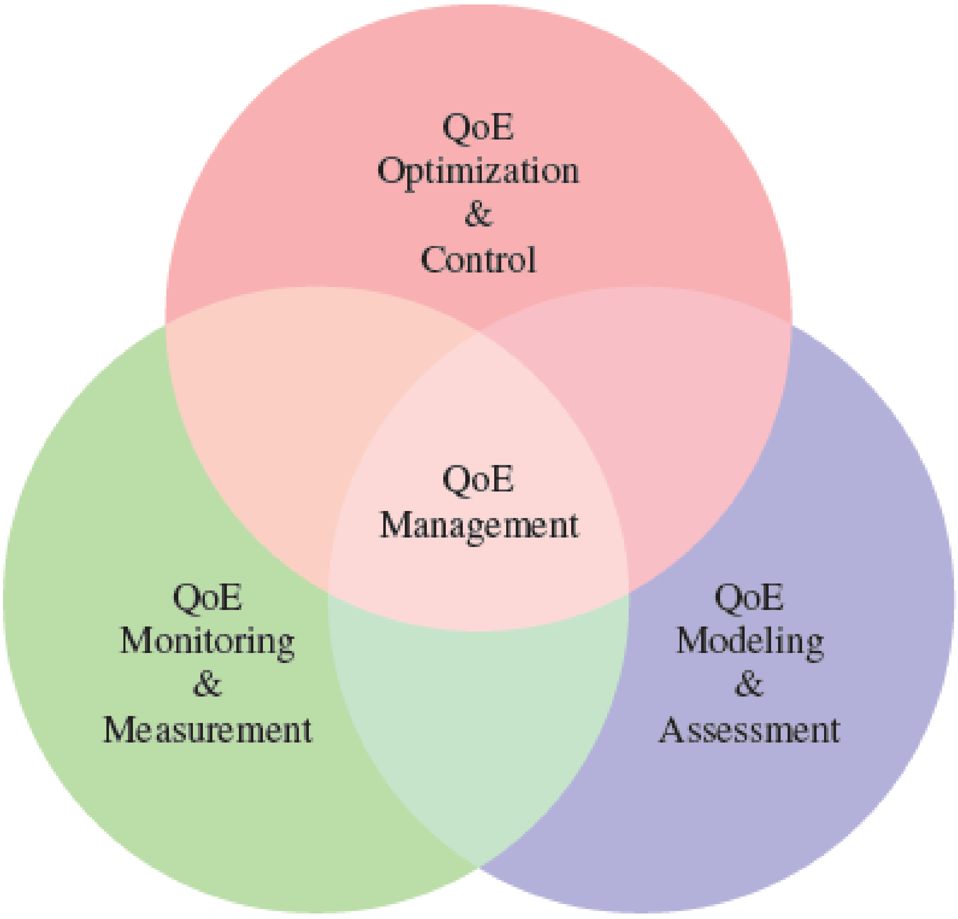
- "Integrated Sensing and Communication Channel: Measurements, Characteristics, and Modeling," IEEE Communications Magazine 2024
  - https://ieeexplore.ieee.org/document/10292797/

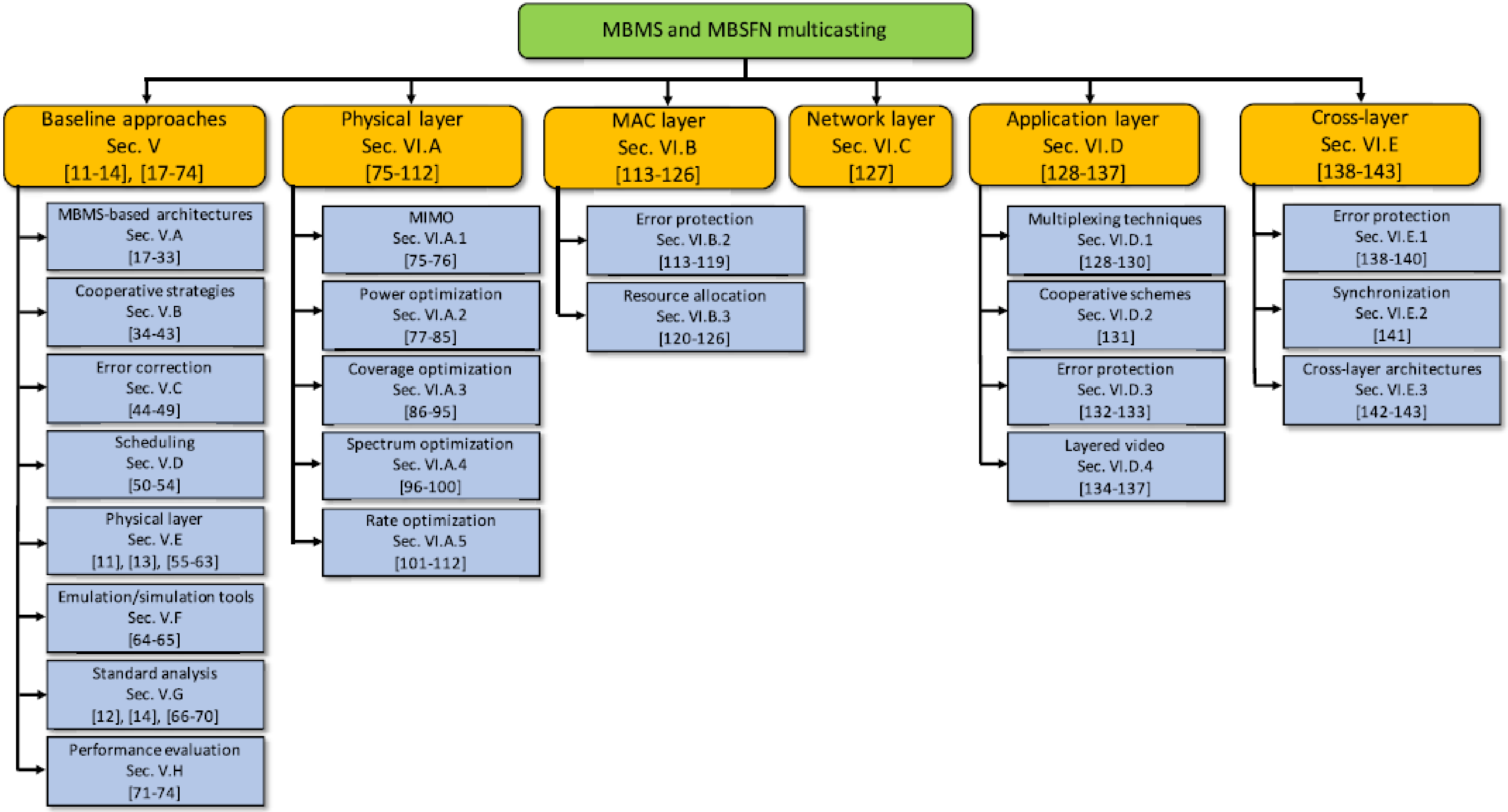
[optional]



Barakabitze et al, "QoE Management of Multimedia Streaming Services in Future Networks: A Tutorial and Survey," IEEE Communications Surveys & Tutorials, 2019

Survey Paper	Year	Topics Covered and Scope	SDN or/and NFV Considerations	QoE in Emerging Architectures	QoE in New Domains
Baraković *et al.* [8]	2013	QoE modeling, monitoring and measurement	No	No	No
Liotou *et al.* [10], Seufert *et al.* [6]	2015	QoE in HTTP adaptive video streaming [6], network-level QoE management in mobile networks [10]	No	No	No
Awobuluyi *et al.* [21]	2015	Context-aware QoE management in the SDN	SDN only	No	No
Zhao *et al.* [32], Su *et al.* [33]	2016	QoE assessment and management in video transmission [32], QoE of video streaming [33]	No	No	No
Wang *et al.* [19]	2016	Architecture for personalized QoE management	Yes	No	No
Peng *et al.* [35]	2017	QoE-oriented mobile edge service management	Yes	MEC only	No
Sousa *et al.* [26]	2017	QoE-based scheduling strategies	No	No	No
Skorin-Kapov *et al.* [25], Petrangeli *et al.* [31]	2018	QoE modeling, QoE monitoring and management [25], QoE-centric management of adaptive video streaming services [31]	To some extent	ICN only [31], MEC only [25]	AR/VR & multisensory
Barman and Martini [30]	2019	QoE modelling for HTTP adaptive video streaming	No	No	No
Barakabitze *et al.* [36]	2019	Network slicing using SDN and NFV	Yes	Yes	No
Our work	2019	(a) A tutorial on QoE modelling and assessment, QoE monitoring and measurement, QoE optimization and control; (b) a survey on QoE management in SDN and NFV, and (c) QoE management using emerging architectures and in new domains	Yes (both SDN and NFV)	Yes (MEC, fog/cloud computing and ICN)	Yes


QoE
Optimization
&
Control
QoE
Management
QoE
Monitoring
&
Measurement
QoE
Modeling
&
Assessment



Striccoli et al, "Multicast and Broadcast Services Over MobileNetworks: A Survey on Standardized Approachesand Scientific Outcomes," IEEE Communications Surveys & Tutorials, 2019

TABLE I
COMPARISON AMONG SURVEY PAPERS ON MULTICAST AND BROADCAST SERVICES

	[162]	[163]	[168]	[169]	**This survey**
Investigation of no-3GPP architectures (i.e., WLAN and WiMAX)		X	X		
Investigation of 3GPP-oriented solutions based on MBMS and MBSFN				X	X
Investigation of 3GPP-oriented solutions based on SC-PTM					X
Investigation of standardized mechanisms and methodologies	X		X	X	X
Advanced approaches for the physical layer	X	X	X	X	X
Advanced approaches for the MAC layer		X	X		X
Advanced approaches for the network layer		X			X
Advanced approaches for the transport layer		X			
Advanced approaches for the application layer		X			X
Advanced cross-layer approaches		X			X
Network architectures for multicast and broadcast services			X	X	X
Coding schema for multicast and broadcast services		X	X	X	X
Optimization algorithms for multicast and broadcast services	X				X

Techniques	Approach	Reference technology	Description	Reference works
MBMS in network architectures	Enhancement and integration of MBMS into different network architectures	MBMS and MBSFN	Analysis of architectures based on MBMS	[17]–[33]
Cooperative strategies	Adoption of cooperative strategies (relay nodes and data forwarding)	MBMS and MBSFN	Multicasting is part of multi-hop cooperative architectures, including D2D and M2M co-operation	[34]–[43]
Error correction	Adoption of coding techniques for error correction and data repair	MBMS and MBSFN	FEC implementations at application and MAC layers, including transmission of redundant data, for error correction and data repair purposes	[44]–[49]
Scheduling of MBMS services	Time-multiplexing of MBMS services for battery saving purposes	MBMS and MBSFN	Scheduling techniques to increase power saving, throughput and robustness against BS failures	[50]–[54]
Physical layer evaluation	Performance evaluation of MBMS at physical layer	MBMS and MBSFN	Evaluation of MBMS performance in terms of SE, size and population of a MBSFN area	[11], [13], [55]–[63]
Implementation of LTE environment	Validation of MBSFN transmission through simulation/emulation tools	MBMS and MBSFN	The MBSFN transmission in LTE and LTE-A environments is implemented according to 3GPP standards, through an implementation of eMBMS in LTE simulators and emulators	[64], [65]
Standard analysis and evaluation	Analysis and evaluation of different aspects of the MBMS and MBSFN standardization	MBMS and MBSFN	Evaluation of MBMS main functionalities (SE, error protection, power consumption, transmission schema for service delivery, etc.) according to 3GPP standard	[12], [14], [66]–[70]
LTE performance evaluation	Performance evaluation of LTE multicasting	MBMS and MBSFN	Analysis of MBMS performance, as regards network dimensioning strategies and wireless communication frameworks, in different	[71]–[74]

Table IV: State-of-the-art of different methods to reduce the explicit channel sounding overhead.

Scheme	Method	Advantage	Disadvantage	MAP-Co suitability
Enhanced explicit	ϕ Only feedback [49]	Existing in 802.11ah with minor change in MAC protocols	This method only supports one data stream and does not reduce overhead significantly.	×
	Time domain channel feedback [50]	Existing in 802.11ad/ay and overhead is lower	Need extra signalling to identify transpose and extra matrix.	✓
	Differential Given rotation [51]	Reducing overhead significantly in 802.11ax/be and 802.11ay	Need additional processing and can experience propagation errors.	×
	Variable angle optimization [52], [53]	Only designed for 802.11ax	Also requires additional processing and signaling.	✓
New Schemes	Multiple component feedback [52]	Reduce feedback overhead	Requires to redesign MAC to change feedback sizes and indication of intervals.	✓
	Codebook based feedback [54]	Well studied and reduced feedback overheadl.	Require additional processing power and new design.	✓
	Deep learning [55], [56]	Predicting CSI based on previous patterns can significantly reduce feedback overhead, making it a great fit for MAP-Co.	To store previously reported CSI, additional processing and storage are required. It may not be feasible for an MA-based architecture.	✓

A Survey on Multi-AP Coordination Approaches over Emerging WLANs: Future Directions and Open Challenges

TABLE I
EXISTING SURVEYS CONCERNING WI-FI-RELATED TOPICS AND ML MODELS

Network	Ref.	Main scope	Addressed Wi-Fi feature	Year
Wi-Fi	[19]	Large-scale network monitoring	Wi-Fi analytics	2020
	[20]	Quality indicators accounting for user satisfaction	Wi-Fi quality indicators	2020
	[21]	Indoor localization	Application-oriented	2020
	[22]			2019
	[23]			2019
	[24]			2018
	[25]	Human activity detection		2017
	[26]	Intrusion detection	Wi-Fi security	2021
	[27]			2016
Wireless networks (IoT, CRN, M2M, MANET)	[37]	Detection and identification of IoT devices	Identification of devices and security protection	2021
	[40]	Federated learning	Privacy protection	2021
	[39]	Applications of transfer learning in wireless networks	Insufficient details concerning Wi-Fi functionalities	2021
	[9]	Performance improvement in a variety of wireless networks like HetNets, CRNs, IoTs, and M2M		2020
	[28]	Performance improvement in the PHY/MAC/Network layers as well as novel networking concepts (MEC, SDN, NFV)		2020
	[38]	Optimization of communication and computing technologies of IoT systems		2020
	[11]	ML models to support resource management, networking and localization in wireless networks	Power saving mechanisms for Wi-Fi infrastructure, indoor localization mechanisms	2019
	[33]	Decision making and feature classification in CRNs	Collaborative coexistence of Wi-Fi networks with other technologies, performance evaluation, dynamic channel selection	2013
	[34]	ML models to support cognitive radio capabilities	Collaborative coexistence of Wi-Fi networks with other technologies	2013
	[35]	ML models to support cognitive radio capabilities	Wi-Fi signal identification	2010

Area	Ref.	ML category	ML mechanisms	Year	Evaluation method	Application of ML	Novelty of approach	ML improvement
Channel access (Section III-A)	[48]	RL	QL	2012	S	Select CW update rule	Apply ABP framework for configuring DCF	Better QoS metrics for voice/video flows
	[49]	RL	PDS	2015	T	Select backoff value	Apply PDS for configuring DCF	Higher throughput, faster convergence than QL
	[50]	SL	RF	2019	S	Select minimum CW value	Improve fairness, robust to selfish stations	Higher throughput and fairness, lower latency
	[51]	RL	QL	2019	S	Select CW value	Apply Q-learning in dense network scenario	Higher throughput
	[52]	SL	fixed-share	2019	S	Select CW value	Apply a fixed-share algorithm for configuring DCF	Higher throughput and fairness, lower latency
	[53]	RL	QL	2020	S	Select time slot for transmission	Stations self-organize into slot-based channel access	Higher throughput and lower latency
	[54]	SL	DT	2020	S	Set AIFS and CW values	Consider QoS requirements	Higher throughput for voice/video flows
	[55]	RL	QL	2020	S	Select CW values	Consider QoS requirements	Higher throughput
	[56]	RL	QL	2020	S	Select time slot for transmission	Consider interference from non-ML based devices	Higher throughput than in cooperative setting
	[57]	RL	DQN, DDPG	2021	S	Select CW value	Apply two DRL variants for configuring DCF	Higher throughput, close to optimal
	[58]	RL	QL	2021	S	Select minimum CW value	Apply DQN with rainbow agent for configuring DCF	Higher fairness, close to optimal
	[59]	RL	DQL	2021	S	Select CW value	Apply FL for configuring DCF	Higher throughput than using only RL
	[60]	RL	DQL, QNN	2021	S	Select time slot for transmission	Apply FL for configuring slotted transmissions	Higher throughput
	[61]	RL	multi-agent RL	2022	S	Select time slot for transmission	Apply multi-agent RL for random channel access scheme	Higher throughput and lower latency
Link adaptation, data rate selection (Section III-B)	[62]	RL	SLA	2008	S+T	Select transmission rate	Apply iterative learning for rate selection	Higher throughput than three SoA methods
	[63]	SL	RF	2013	S	Select transmission rate	Apply the random forests method for rate selection	Higher throughput than three SoA methods
	[64]	SL	ANN, MLP	2013	S	Select transmission rate	Use number of stations, channel conditions, and traffic intensity as input	Higher throughput than two SoA methods
	[65]	RL	MAB	2016	S	Configure link parameters	Apply MAB for link adaptation	Higher throughput, lower packet loss and delay than three SoA methods
	[66]	SL	RF	2018	S	Classify channel type	Apply SL for channel classification	Higher spectral efficiency
	[67]	SL	ANN	2020	E	Select transmission rate	Provide extensible rate selection framework	Higher throughput than three SoA methods
	[68]	SL	DNN	2020	E	Predict link-layer throughput	Apply SL for link adaptation	Higher throughput, lower packet loss and delay than three SoA methods
	[69]	RL	TS	2020	S	Select guard interval	Apply TS for guard interval selection	Higher throughput, lower packet loss and delay vs static settings
	[70]	RL	SARSA	2020	S	Select transmission rate	Apply RL for rate selection in industrial settings	Higher throughput, lower delay than SOA method
	[71]	RL	particle filter	2020	S	Select transmission rate	Apply RL for 802.11ax rate selection	Higher throughput, lower delay than two SOA methods
	[72]	RL	QL	2021	S	Select transmission rate	Use packet timeouts to train RL model	Higher throughput than a SoA method
	[73]	RL	DQN	2021	E	Select transmission rate	Apply DRL for rate selection	Higher throughput than two SoA methods