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Glossary of Terms

AIP	Average Interference Power
AM	Availability Metric
AWGN	Additive White Gaussian Noise
CCC	Common Control Channel
CR	Cognitive Radio
CRCN	Cognitive Radio Cognitive Network
CRN	Cognitive Radio Network
CS	Channel Sequence
CSCG	Circular Symmetric Complex Gaussian
CSI	Channel State Information
CSS	Cooperative Spectrum Sensing
CTS	Clear To Send
DCSS	Distributed Cooperative Spectrum Sensing
DMDD	Distributed Medium access control protocol for Data Dissemination
DSA	Dynamic Spectrum Access
DPA	Distributed Power Allocation
ED	Energy Detection
EM	Expectation Maximization
FC	Fusion Center
FCC	Federal Communications Commission
FIFO	First In First Out
GHz	Giga Hertz
GPS	Global Positioning System
GSM	Global System for Mobile communications
HMM	Hidden Markov Model
i.i.d.	Independent and identically distributed
IPC	Interference Power Constraint
ISM	Industry Science and Medical
IWF	Iterative Water Filling
KKT	Karush-Kuhn-Tucker
LRT	Likelihood Ratio Test
MAC	Medium Access Control
NE	Nash Equilibrium
NP	Neyman-Pearson
ns2	network simulator 2
OFDM	Orthogonal Frequency Division Multiplexing

OFDMA	Orthogonal Frequency Division Multiple Access
PDF	Probability Density Function
PF	Parallel Fusion
PIP	Peak Interference Power
PR	Primary Radio
PRx	Primary Receiver
PTx	Primary Transmitter
PU	Primary User
ROC	Receiver Operating Characteristic
RSS	Received Signal Strength
RTS	Request To Send
SDR	Software Defined Radio
SIFS	Short Inter Frame Spacing
SINR	Signal-to-Interference-Noise-Ratio
s-mac	Sensor-Medium Access Control
SN	Secondary Network
SNR	Signal-to-Noise-Ratio
SRx	Secondary Receiver
STx	Secondary Transmitter
SU	Secondary User
SYNC	Synchronize
TACSS	Threshold Adaptive Cooperative Spectrum Sensing
UCRN	Underlay Cognitive Radio Network
UPA	Underlay Power Allocation
UTC	Universal Coordinated Time
WF	Water Filling

Symbols and Notations

P_d	Probabilities of detection
P_f	Probability of false alarm
P_m	Probability of miss detection
$x(t)$	Received signal at a SU
$s(t)$	Transmitted PU signal
$h(t)$	Amplitude gain of the sensed channel
$n(t)$	Additive white Gaussian noise (AWGN) with mean zero
H_0	Hypothesis of absence
H_1	Hypothesis of presence
Y	Decision statistic in Energy Detection (ED)
λ	Decision threshold in Energy Detection (ED)
T_S	Sensing duration/period
T_R	Total reporting time for all the SUs in a coalition to the head
$T_{r,i}$	Time required to report local sensing information to the coalition head for a SU i
T_C	Total time taken by the coalition head to compute and transmit the final results to every SU in a coalition
T_T	Time duration available for data transmission in a time slot T
E	Energy consumed by a SU in time slot T
E_S	Energy consumed during sensing by a SU
E_R	Energy consumed for reporting the local sensing information to coalition head by a SU
E_{RC}	Energy consumed for receiving the final sensing result from the coalition head
E_T	Energy consumed for data transmission
e_s	Sensing energy per bit
e_l	Energy consumed by the reception circuitry per bit
e_d	Energy dissipated per bit per $metre^2$
e_t	Energy spent by transmission circuitry per bit
$P_{f,i}$	Probability of false alarm of a SU i
$P_{d,i}$	Probability of detection of a SU i
$P_{m,i}$	Probability of miss detection of SU i
$P_{f,S}$	Probability of false alarm of a coalition S
$P_{f,td,S}$	The target probability of false alarm for a coalition S
$\hat{P}_d$	Target probability of detection of a SU i

$P_{f,avg}$	Average probability of false alarm of all the SUs in the network
λ_i	Energy Detection (ED) threshold for a SU i
γ_i	Received SNR from the PU to i^{th} SU
P_i	PU signal power received at i^{th} SU
u	Time bandwidth product
$Q(.)$	Complementary distribution function of the standard Gaussian
P_{PU}	PU signal power
κ	Path-loss constant
d_i	Distance of i^{th} SU from the PU
R_i	Average throughput of i^{th} SU
P_{H_0}	Probability of PU being absent
r_i	Transmission rate of i^{th} SU
S_{op}	Optimal size of a coalition S
$d_{avg,i}$	Average distance between i^{th} SU and all other SUs in a coalition
$d_{avg,min}$	Minimum average distance between each SU and all other SUs in a coalition S
V_{avg}	Vector consisting of average distances between SUs and all other SUs in a coalition S
SNR	Signal to noise ratio
$\Gamma(.,.)$	Incomplete Gamma function
$\Gamma()$	Gamma function
$\gamma_{i,PU}$	Average SNR of the received signal at i^{th} SU from the PU
$h_{PU,i}$	Path loss between PU and SU i
P_{PU}	PU signal power
σ^2	Gaussian noise variance
μ	Path loss exponent
$d_{PU,i}$	Distance between i^{th} SU receiver and the PU
$P_{e,i,l}$	Probability of error of i^{th} SU to the coalition head l
$\gamma_{i,l}$	Average SNR at the coalition head l from i^{th} SU
$h_{i,l}$	Path loss between i^{th} SU and coalition head l
$d_{i,l}$	Distance between i^{th} SU receiver and the coalition head l
$Q_{m,S}$	Probability of miss detection of a coalition S
$Q_{f,S}$	Probability of false alarm of a coalition S
$V_{i,D}$	Distance vector
$d_{i,j}$	Distance between i^{th} SU and j^{th} SU
$V_{D,avg}$	Global average distance vector
$d_{avg,min}$	Minimum average distance between each SU and all other SUs in a coalition
$E_{T,i}$	Energy consumed for reporting the local sensing result by i^{th} SU to the coalition head
α	Maximum tolerable probability of false alarm
$\hat{P}_{d,i}$	Probability of detection of i^{th} SU with adaptive sensing threshold λ_i

$\hat{P}_{f,i}$	Probability of false alarm of i^{th} SU with adaptive sensing threshold λ_i
$\hat{P}_{m,i}$	Probability of miss detection of i^{th} SU with adaptive sensing threshold λ_i
$\hat{P}_{e,i,l}$	Probability of error of i^{th} SU to the coalition head l while adaptive sensing threshold is considered
$\hat{Q}_{m,S}$	Probability of miss detection of a coalition S while adaptive sensing threshold of SUs is considered
$\hat{Q}_{f,S}$	Probability of false alarm of a coalition S while adaptive sensing threshold of SUs is considered
$P_{f,min}$	Minimum probability of false alarm
$P_{e,min}$	Minimum probability reporting error
S_{max}	Maximum number of SUs in a coalition S
$\mathbb{D}$	Defection function
PTx	PU transmitter
PRx	PU receiver
STx	SU transmitter
SRx	SU receiver
g_p	Channel State Information (CSI) in terms of channel gain between PTx and PRx
g_1	CSI vector between SU transmitter (STx) and PU receiver (PRx)
g_{1n}	Channel gain from STx and PRx in sub-channel n
g_2	CSI vector between SU transmitter (STx) and SU receiver (SRx)
g_{2n}	Channel gain from STx and SRx in sub-channel n
p_{max}	The maximum total transmit power at STx
$\boldsymbol{P}$	Power allocation vector of the SU transmitter
p_n	SU transmitter power in sub-channel n
N_0	AWGN noise present in the channel
I_{max}	Average Interference Power (AIP) threshold of Primary receiver
p_{int}	The allowable maximum transmission power at STx constrained by AIP threshold
$\mathbf{G}$	The channel gain matrix representing CSI, whose (m, n) entry represents the channel gain of the link for SU m using channel n
$p_{m,n}$	SU m's transmit power in sub-channel n
$g_{m,n}$	Represents the channel gain of the link for SU m using sub-channel n
$\gamma_{m,n}$	Signal-to-Interference-plus-Noise-Ratio (SINR) of signal from SU m using sub-channel n
$p_{k,n}$	PU k's transmit power in sub-channel n
$g_{k,n}$	Represents the channel gain of the link for PU k using sub-channel n
p_m^{max}	The allowable maximum transmission power of SU m
p_m^{tmax}	The allowable total transmission power of SU m

R_m	The transmission rate of SU m calculated using Shannon's Law
$\mathbf{P}_m$	Power allocation vector of the SU m
$\mathbf{P}$	Outcome power allocation vector of the all the SUs using all the channels
$\mathcal{G}$	Represents the non-cooperative strategic Game
$\mathcal{M}$	Set of players in the game $\mathcal{G}$
$\mathcal{S}_m$	Game playing strategy of player m
$\mathcal{U}_m$	Utility function of player m
μ_m	Lagrange multiplier for player m. The inverse of μ_m represents the water level
O_t	Represents the observation symbol seen by a SU at any given observation instance t
I_t	The total interference power in terms of IPC received by any PRx at any given instance t
Z_k	The interference power threshold that is tolerable by a PRx
T	Represents the number of observation slots to be used by SUs
O	Represents the observation sequence
O_{next}	Represents the observation sequence in next period
S_1	Represents the OFF state (i.e. PU is OFF in the channel) of HMM
S_2	Represents the ON state (i.e. PU is ON in the channel) of HMM
S_3	Represents the ON_OFF state (i.e. PU is on in the channel, but usable by SU) of HMM
H	Represents the HMM for a licensed channel
$\mathfrak{N}$	Total number of states in HMM
M	Total number of distinct observation symbols of HMM
A	The state transition probability matrix of HMM
B	The observation symbol probability distribution matrix of HMM
π	The initial state probability distribution vector of HMM
T^c_{OFF}	Random variable representing distribution of S_1 for channel C
T^c_{ON}	Random variable representing distribution of S_2 for channel C
$T^c_{ON\_OFF}$	Random variable representing distribution of S_3 for channel C
I	Random variable representing IPC for channel C
AM_C	Availability metric (AM) for a channel C
U_{seq}	Average separation between two 0s in a observation sequence string
L_{seq}	Length of observation sequence string
S^0_{seq}	Number of symbol 0 in an observation sequence string
ℓ	log-likelihood of observation sequence
$\mathcal{S}$	Represents sender node which disseminate a message

$\mathcal{N}(\mathcal{S})$	Set of the neighbours of node $\mathcal{S}$
$\mathcal{W}(u)$	Size of the neighbour of node u
$\mathcal{S}_f$	Represents forwarding node (responsible for next hop level dissemination)
$\mathcal{P}_{list}$	Preferable list of $\mathcal{S}_f$ nodes (i.e. forwarding nodes)
$\mathcal{R}_x$	Set of nodes that receives a message from node $\mathcal{S}$
$\mathcal{C}(u)$	Best selected channel for dissemination by node u
$\mathcal{K}$	1^{st} element of $\mathcal{P}_{list}$