?
$1ms$
N
U
K
S
0
a_u
u
b_{su}
u
s
w_{ksu}
u
s
k
u
s
k
p_{ksu}
u
$c_{vB,u}$
C_{cBUP}
$\omega_u \in$
$[0,1]$
$v_n \in$
$[0,1]$
$\sum_n v_n =$
1

$$\rho_{sku} = \frac{p_{sku} g_{sku}}{P_{AWGN} + \sum_{i \in S/\{s\}} \sum_{j \in U/\{u\}} a_j b_{ij} w_{ijk} p_{ijk} g_{ijk}}. \quad (1)$$

$$r_{sku} = B \log_2 (1 + \rho_{sku}). \quad (2)$$

$I_{max,sku}$
P_{max}
C_{fh}
C_{bh}

$$\max_{a_u, b_{su}, w_{sku}, p_{sku}, c_{vB,u}} \sum_{s \in S} \sum_{k \in K} \sum_{u \in U} v_n \omega_u a_u b_{su} w_{sku} r_{sku} subjectto a_u \sum_{s \in S} \sum_{k \in K} b_{su} w_{sku} r_{sku} \geq a_u R_{min,u}, \forall u, a_u \sum_{s \in S} \sum_{k \in K} b_{su} w_{sku} r_s \quad (3)$$

?
$c_{vB,u} \geq$
$R_{min,u}$

$$\max_{b_{us}} \sum_{s \in S} \sum_{u \in U} W_u a_u subjectto \sum_{u \in U} b_{su} R_{min,u} \leq C_{xh,s}, \forall s, \sum_{s \in S} b_{su} = 1 a_u \in \{0,1\} \forall u \quad (4)$$

$$\rho_{wb,su} = \frac{P_{max} \hat{g}_{su}}{P_{AWGN} + \sum_{i \in S/\{s\}} P_{max,i} \hat{g}_{iu}}. \quad (5)$$

$$\max_{b_{su}} \sum_{u \in U} \sum_{s \in S} W_u b_{su} \rho_{wb,su} subjectto \sum_{u \in U} a_u R_{min,u} \leq R_{cBUP}, \forall u, b_{su} \in \{0,1\} \forall u \forall s \quad (6)$$

$$\max_{c_{v,BU}} \sum_{u \in U} W_u c_{v,BU} subjectto \sum_{u \in U_{RRH}} c_{v,BU} \leq C_x, \forall u, R_{min,u} \leq c_{vB,u} \leq R_{max,u}, \forall u, \sum_{s \in S} c_{vB,u} \leq C_{cBUP} c_{vB,u} \geq 1 \forall u \quad (7)$$

?
?
?
?
?
??
N_U
N_R
$\tilde{x}^{dl}$
$s =$
$[s_1; ...; s_{N_U}]$
s_k
k
$\tilde{x}^{dl}$

$$\tilde{x}^{dl} = W P^{\frac{1}{2}} s, \quad (8)$$

$$\tilde{x}^{dl} = [\tilde{x}^{dl}_1; ...; \tilde{x}^{dl}_{N_R}] \quad (9)$$

W
$N_R \times$
N_U
$W =$
$[w_1, ..., w_{N_U}]$
$P^{\frac{1}{2}} =$
$diag(\sqrt{p_1}, ..., \sqrt{p_{N_U}})$

$$x^{dl} = \tilde{x}^{dl} + Q, \quad (10)$$

$Q =$
$[q_1, \ldots, q_{N_R}]^T$
$\forall i q_i \mathcal{N}(0, \sigma_{q_i^2})$