x
M
$\tilde{x}$
$\tilde{x}$
$\tilde{x}^{dl} = [\tilde{x}_1^{dl}; ...; \tilde{x}_{N_R}^{dl}] = As$
(1)
A
s
$A =$
$[A_1, ..., A_{N_U}]$
$s =$
$[s_1; ...; s_{N_U}]$
$x^{dl} = \tilde{x}^{dl} + Q,$
(2)
$Q =$
$[q_1, \ldots, q_{N_u}]^T$
$q_i \mathcal{N}(0, \sigma_{q^2})$
$\tilde{x}^{dl} = WP^{\frac{1}{2}}s,$
A
P
W
N_r
$y_j = H_j x + z_j$
(3)
y_j
j
H_j
$1 \times$
N_r
z_j
$z_j \mathcal{N}(0, 1)$
i
$P_i(W, \sigma) = \frac{1}{T} E[||x_i||^2] = trace(w_i P^{\frac{1}{2}} P^{H\frac{1}{2}} {w_i}^H + \sigma_{q_i}^2(I))$
(4)
$W =$
$[w_1, ..., w_{N_U}]$
$\sigma_{q_i}^2$
i
$C_i(W, \sigma_q) = \log det(w_i P^{\frac{1}{2}} P^{H\frac{1}{2}} {w_i}^H + \sigma_{q_i}^2(I)) - N_r \log(\sigma_{q_i}^2)$
(5)
j

$$R(W, \sigma_q)_j = I_H(s_j, y_j) = \log det(I + H_j(W_j {W_j}^H + \sigma_x \times I){H_j}^H) - \log det(I + H_j(\sum_{k \in N_u, k \neq j} W_k {W_k}^H + \sigma_x \times I){H_j}^H)$$

(6)
I_H
$\max_{W,\sigma} \sum R(W, \sigma_q) subject to \bar{P}_i(W, \sigma_q) \leq P_{max} \forall i C_i(W, \sigma_q) \leq C^{th} \forall i$
(7)
$\bar{P}_i(W, \sigma_q)$
i
$C_i(W, \sigma_q)$
i
σ_q
W
S
v
R_v
D_v
$r_{(s,n)}$
n
s
$d_{(s,k)}$
k
s
s

$$y_{\mathcal{D}_s} = \sum_{v=1}^{S} H_{\mathcal{R}_v, \mathcal{D}_s}^H W_{R_v, D_v} P_{D_v}^{\frac{1}{2}} x_{\mathcal{R}_v} + z_{\mathcal{D}_s},$$

(8)
$x_{\mathcal{D}_v} =$
$[x_{d_{(v,1)}}, ..., x_{d_{(v,D_v)}}]^T \in$
$C^{\mathcal{D} \times T}$
t
T
1
$W_{R_v, D_v} =$
$[w_{R_v, d_{(v,1)}}, ..., w_{R_v, d_{(v,D_v)}}]^T \in$
$C^{R_v \times D_v}$
0
z_{D_s}
$z_{\mathcal{D}_s} \mathcal{N}(0, N_0 I_{D_s})$
N_0
H_{R_v, D_s}
R_v
D_s
$H_{\mathcal{R}_v, \mathcal{D}_s} =$
$[$ $]^T$