

# 1 SchemePBAC

## 1.1 Setup() $\rightarrow$ (*mpk*, *msk*)

$q \leftarrow \|\mathbb{G}\|$   
 $g \leftarrow 1_{\mathbb{G}_1}$   
 generate  $s, \alpha \in \mathbb{Z}_r$  randomly  
 $H_1 : \{0, 1\}^* \rightarrow \mathbb{G}_1$   
 $H_2 : \{0, 1\}^* \rightarrow \mathbb{G}_1$   
 $H_3 : \mathbb{G}_T^2 \times \{0, 1\}^\lambda \rightarrow \mathbb{Z}_r$   
 $H_4 : \{0, 1\}^* \rightarrow \{0, 1\}^\lambda$   
 $H_5 : \{0, 1\}^* \rightarrow \mathbb{G}_1$   
 $H_6 : \{0, 1\}^* \rightarrow \mathbb{G}_1$   
 $\hat{g} \leftarrow g^s$   
 $mpk \leftarrow (g, \hat{g}, H_1, H_2, H_3, H_4, H_5, H_6)$   
 $msk \leftarrow (x, \alpha)$   
**return** (*mpk*, *msk*)

## 1.2 SKGen(*id<sub>S</sub>*) $\rightarrow$ *ek<sub>id<sub>S</sub></sub>*

$ek_{id_S} \leftarrow H_1(id_S)^\alpha$   
**return** *ek<sub>id<sub>S</sub></sub>*

## 1.3 RKGen(*id<sub>R</sub>*) $\rightarrow$ *dk<sub>id<sub>R</sub></sub>*

$dk_{id_R,1} \leftarrow H_2(id_R)^\alpha$   
 $dk_{id_R,2} \leftarrow H_2(id_R)^s$   
 $dk_{id_R} \leftarrow (dk_{id_R,1}, dk_{id_R,2})$   
**return** *dk<sub>id<sub>R</sub></sub>*

## 1.4 Enc(*ek<sub>id<sub>1</sub></sub>*, *id<sub>2</sub>*, *m*) $\rightarrow$ *ct*

generate  $\eta_1, \eta_2 \in \mathbb{G}_T$  randomly  
 $r \leftarrow H_3(\eta_1, \eta_2, m)$   
 $C_1 \leftarrow g^r$   
 $C_2 \leftarrow \eta_1 \cdot e(\hat{g}, H_2(id_2)^r)$   
 $C_3 \leftarrow \eta_2 \cdot e(ek_{id_1}, H_2(id_2))$   
 $C_4 \leftarrow m \oplus H_4(\eta_1) \oplus H_4(\eta_2)$   
 $S \leftarrow H_5(id_2 || C_1 || C_2 || C_3 || C_4)^r$   
 $C \leftarrow (C_1, C_2, C_3, C_4, S)$   
**return** *C*

## 1.5 PKGen(*ek<sub>id<sub>2</sub></sub>*, *dk<sub>id<sub>2</sub></sub>*, *id<sub>1</sub>*, *id<sub>2</sub>*, *id<sub>3</sub>*) $\rightarrow$ *rk*

generate  $N_1 \in \{0, 1\}^\lambda$  randomly  
 generate  $N_2 \in \{0, 1\}^\lambda$  randomly  
 $K_1 \leftarrow e(dk_{id_2,2}, H_2(id_3))$   
 $K_2 \leftarrow e(ek_{id_2}, H_2(id_3))$   
 $rk_1 \leftarrow (N_1, H_6(K_1 || id_2 || id_3 || N_1) \cdot dk_{id_2,2})$   
 $rk_2 \leftarrow (N_2, H_6(K_2 || id_2 || id_3 || N_2) \cdot dk_{id_2,1})$   
 $rk \leftarrow (id_1, id_2, rk_1, rk_2)$

**return**  $rk$

### 1.6 ProxyEnc( $ct, rk$ ) $\rightarrow CT$

$h \leftarrow H_5(id_2 || C_1 || C_2 || C_3 || C_4)$   
**if**  $e(h, C_1) = e(g, S)$  **then**  
 generate  $t \in \mathbb{Z}_r$  randomly  
 $C'_2 \leftarrow C_2 / \frac{e(C_1, rk_{1,2} \cdot h^t)}{e(g^t, S)}$   
 $C'_3 \leftarrow C_3 / e(H_1(id_1), rk_{2,2})$   
 $CT \leftarrow (id_1, C_1, C'_2, C'_3, C_4, rk_{1,1}, rk_{2,1})$   
**else**  
 $CT \leftarrow \perp$   
**end if**  
**return**  $CT$

### 1.7 Dec<sub>1</sub>( $dk_{id_2}, id_2, id_1, ct$ ) $\rightarrow m$

$h \leftarrow H_5(id_2 || C_1 || C_2 || C_3 || C_4)$   
 generate  $t \in \mathbb{Z}_r$  randomly  
 $\eta_1 \leftarrow C_2 / \frac{e(C_1, dk_{id_2,2} \cdot h^t)}{e(g^t, S)}$   
 $\eta_2 \leftarrow C_3 / e(dk_{id_2,1}, H_1(id_1))$   
 $m \leftarrow C_4 \oplus H_4(\eta_1) \oplus H_4(\eta_2)$   
 $r \leftarrow H_3(\eta_1, \eta_2, m)$   
**if**  $S \neq h^r \vee C_1 \neq g^r$  **then**  
 $m \leftarrow \perp$   
**end if**  
**return**  $m$

### 1.8 Dec<sub>2</sub>( $dk_{id_3}, id_3, id_2, CT$ ) $\rightarrow m'$

$K'_1 \leftarrow e(dk_{id_3,2}, H_2(id_2))$   
 $K'_2 \leftarrow e(dk_{id_3,1}, H_1(id_2))$   
 $\eta'_1 \leftarrow C'_2 \cdot e(C_1, H_6(K'_1 || id_2 || id_3 || N_1))$   
 $\eta'_2 \leftarrow C'_3 \cdot e(H_6(K'_2 || id_2 || id_3 || N_2), H_1(id_1))$   
 $m' \leftarrow C_4 \oplus H_4(\eta'_1) \oplus H_4(\eta'_2)$   
 $r' \leftarrow H_3(\eta'_1, \eta'_2, m')$   
**if**  $C_1 \neq g^{r'}$  **then**  
 $m' \leftarrow \perp$   
**end if**  
**return**  $m'$