

1 SchemeIBPME

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

$q \leftarrow \|\mathbb{G}\|$
 generate $g \in \mathbb{G}_1$ randomly
 generate $h \in \mathbb{G}_1$ randomly
 generate $x, \alpha \in \mathbb{Z}_p^*$ randomly
 $H_1 : \{0, 1\}^* \rightarrow \mathbb{G}_1$
 $H_2 : \{0, 1\}^* \rightarrow \mathbb{G}_1$
 $H_3 : \{0, 1\}^* \rightarrow \mathbb{Z}_p^*$
 $H_4 : \{0, 1\}^* \rightarrow \mathbb{G}_1^2$
 $H_5 : \{0, 1\}^* \rightarrow \mathbb{G}_1$
 $H_6 : \{0, 1\}^* \rightarrow \mathbb{G}_1$
 $H_7 : \{0, 1\}^* \rightarrow \mathbb{G}_1$
 $y \leftarrow g^x$
 $mpk \leftarrow (G, G_T, q, g, e, h, H_1, H_2, H_3, H_4, H_5, H_6, H_7, y)$
 $msk \leftarrow (x, \alpha)$
return (*mpk*, *msk*)

1.2 DKGen(*id_R*) \rightarrow *dk_{id_R}*

$dk_{id_R,1} \leftarrow H_1(id_R)^x$
 $dk_{id_R,1} \leftarrow H_1(id_R)^\alpha$
 $dk_{id_R} \leftarrow (dk_{id_R,1}, dk_{id_R,2})$
return *dk_{id_R}*

1.3 EKGen(*id_S*) \rightarrow *ek_{id_S}*

$ek_{id_S} \leftarrow H_2(id_S)^\alpha$
return *ek_{id_S}*

1.4 ReEKGen(*ek_{id₂}*, *dk_{id₂}*, *id₁*, *id₂*, *id₃*) \rightarrow *rk*

generate $N \in \{0, 1\}^\lambda$ randomly
 generate $\bar{x} \in \mathbb{Z}_p^*$ randomly
 $rk_1 \leftarrow g^{\bar{x}}$
 $rk_2 \leftarrow dk_{id_2,1} h^{\bar{x}} H_6(e(y, H_1(id_3))^{\bar{x}})$
 $K \leftarrow e(ek_{id_2}, H_1(id_3))$
 $rk_3 \leftarrow e(H_2(id_1), H_7(K || id_2 || id_3 || N) \cdot dk_{id_2,2})$
 $rk \leftarrow (N, rk_1, rk_2, rk_3)$
return *rk*

1.5 Enc(*ek_{id₁}*, *id₂*, *m*) \rightarrow *ct*

generate $\sigma \in \mathbb{G}_1$ randomly
 generate $\eta \in \mathbb{G}_T$ randomly
 $r \leftarrow H_3(m || \sigma || \eta)$
 $ct_1 \leftarrow h^r$
 $ct_2 \leftarrow g^r$
 $ct_3 \leftarrow (m || \sigma) \oplus H_4(e(y, H_1(id_2))^r) \oplus H_4(\eta)$

$ct_4 \leftarrow \eta \cdot e(ek_{id_1}, H_1(id_2))$
 $ct_5 \leftarrow H_5(ct_1 || ct_2 || ct_3 || ct_4)^r$
 $ct \leftarrow (ct_1, ct_2, ct_3, ct_4, ct_5)$
return ct

1.6 ReEnc(ct, rk) $\rightarrow ct'$

If $e(ct_1, g) = e(h, ct_2) \wedge e(ct_1, H_5(ct_1 || ct_2 || ct_3 || ct_4)) = e(h, ct_5)$ **then**
 $ct'_4 \leftarrow \frac{ct_4}{rk_3}$
 $ct_7 \leftarrow \frac{e(rk_2, ct_2)}{e(ct_1, rk_1)}$
 $ct' \leftarrow (ct_2, ct_3, ct'_4, ct_6, ct_7, N)$
else
 $ct' \leftarrow \perp$
return ct'

1.7 Dec₁(dk_{id_2}, id_1, ct) $\rightarrow m$

If $e(ct_1, g) = e(h, ct_2) \wedge e(ct_1, H_5(ct_1 || ct_2 || ct_3 || ct_4)) = e(h, ct_5)$:
 $V \leftarrow e(dk_{id_2, 2}, H_2(id_1))$
 $\eta' \leftarrow \frac{ct_4}{V}$
 $r \leftarrow H_3((ct_3 \oplus H_4(e(dk_{id_2, 1}))) \oplus H_4(\eta')) || \eta'$
If $g^r = ct_2$:
return m

1.8 Dec₂($dk_{id_3}, id_1, id_2, ct'$) $\rightarrow m$

$V \leftarrow e(dk_{id_3, 2}, H_2(id_2))$
 $\eta' \leftarrow ct'_4 \cdot e(H_2(id_1), H_7(V || id_2 || id_3 || N))$
 $R \leftarrow \frac{ct_7}{e(H_6(e(dk_{id_3, 1}, ct_6), ct_2))}$
 $r \leftarrow H_3((ct_3 \oplus H_4(R) \oplus H_4(\eta')) || \eta')$
If $g^r = ct_2$:
return m