



- (51) **International Patent Classification:**
Not classified
- (21) **International Application Number:**
PCT/SG2022/050769
- (22) **International Filing Date:**
26 October 2022 (26.10.2022)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
10202112269T 05 November 2021 (05.11.2021) SG
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- (81) **Designated States** (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.
- (84) **Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU,

(54) **Title:** METHOD AND SYSTEM FOR PROTECTING DIGITAL SIGNATURES

Algorithm 2: Quantum-resistant ECDSA signing $Sign_q$.

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1 begin
2    $G \leftarrow$  ECC base point;  $P \leftarrow$  ECC order;
3    $\rho \leftarrow$  secret pre-image;
4    $M \leftarrow$  message;
5   Generate signature random  $r$ ;
6   Compute  $r^{-1}$  where  $r * r^{-1} \equiv 1 \text{ mod } P$ ;
7   Compute  $R = (R_x, R_y)$  where  $R \equiv r * G \text{ mod } P$ ;
8   Compute hash of message  $H(M)$ ;
9   Enumerate ZKBoo proof  $\pi =$  begin
10    Zero-knowledge computation of private key  $K_s$  where  $K_s = H(\rho)$ ;
11    Zero-knowledge computation of public key  $K_p$  where
        $K_p \equiv K_s * G \text{ mod } P$ ;
12    Compute  $s$  where  $s \equiv r^{-1} * (H(M) + R_x * K_s) \text{ mod } P$ ;
13    Commit  $R_x, s$  in the proof;
14  end
15  destroy  $r, r^{-1}, K_s$ ;
16  return  $\sigma = \{R_x, s\}, \pi$ ;
17 end

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200

FIG. 2

(57) **Abstract:** A method for quantum-resistant digitally signing data, a method for verification of a quantum resistant digital signature for authentication of a source of data by verifying a private key, and a quantum resistant digital signature system are provided. The quantum resistant digital signature system includes a digital signature system and a layer of quantum resistant protection. The digital signature system includes a public key and a private key, wherein the public key is associated with the private key. The digital signature system also includes a digital signature generated in response to data and the private key. The layer of quantum resistant protection is applied to the digital signature system and includes a signing-party-provided quantum-secure proof of knowledge of a pre-image of the private key.

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TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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