Related Work

Identity Based Encryption The first concept of Identity-Based Encryption (IBE) was introduced by Shamir in 1984 [21]. Although Shamir easily constructed an identity-based signature scheme based on RSA, the use case of IBE remained an open problem until the introduction of bilinear maps. In [5] Boneh and Franklin propose the first practically usable IBE scheme based on the Weil pairing. However, the security proof in [5] still relies on the random oracle assumption. Canetti et al. [7] succeed in proposing a secure IBE scheme without having to rely on the random oracle model. However, the attacker model in [7] requires the adversary to declare which identity it will target, therefore the scheme in [4] is considered more secure as attackers can adaptively choose the targeted identity. Gentry [12] proposes a more efficient alternative to this scheme without random oracles while achieving shorter public parameters.

Broadcast Encryption Fiat and Naor introduced the first concept of Broadcast Encryption (BE) in [11]. The implementation in [11] requires a ciphertext of size $O\left(t \log^2 t \log n\right)$ to be secure against t colluding users. The first fully collusion resistant scheme was proposed in [19] by Naor et al. thereby making the ciphertext size independent of the number of colluding users. Halevy and Shamir further reduce the required ciphertext length for collusion resistant schemes in [15]. It is the first paper in a series of many ([9], [14] and [17]) that achieves a ciphertext size that is only dependent on the number of revoked users $O(r)$. Boneh, Gentry and Waters [6] consider using bilinear maps to achieve constant size ciphertexts and $O(n)$ public keys.

Identity Based Broadcast Encryption Sakai and Furukawa are the first to define a collusion resistant identity based broadcast encryption (IBBE) scheme in [20]. Independently from [20] Delerablée realises a similar identity based broadcast encryption scheme and claims to be the first as well in [8]. The size of the public key in both [20] and [8] is proportional to the maximum size of the intended set of recipients while realising short ciphertexts and private keys. Baek et al. [1] define an IBBE scheme that requires only one pairing computation. The scheme in [1] is proven secure under the random oracle assumption where the attacker ties himself to a selective-ID attack. Gentry and Waters achieve identity based broadcast encryption with sublinear ciphertexts in [13]. Their scheme is proven secure against a stronger notion of adaptive security where the attacker can adaptively alter its queries depending on earlier received information. Barbosa and Farshim [2] proposed an identity-based key encapsulation scheme for multiple parties which is an extension of *mKEM* as considered by Smart [22] to the identity-based setting. An mKEM is a Key Encapsulation Mechanism which takes multiple public keys as input. An encrypted message under mKEM consists of an encapsulated session key K and a symmetric encryption of the plaintext message M under K.

Recipient Anonymous Broadcast Encryption All earlier mentioned references describing BE require the intended set of recipients to be published to realise a higher efficiency. Barth, Boneh and Waters [3] are the first to design a BE scheme that takes the anonymity of the recipient into account. The proposed anonymous broadcast

encryption (ANOBE) scheme imposes a linear dependency of the ciphertext on the number of recipients and can only be proven secure in the random oracle model. In [18] Libert et al., propose an alternative ANOBE scheme that is proven secure in the standard model. Both [3] and [18] propose a tag based system that allows efficient decryption at the cost of making the public master key linear dependent on the total number of users. Krzywiekci et al. [16] propose a scheme that is proportional to the number of revoked users. In [23], Yu et al. design an architecture that even hides the number of users in the recipient set. Fazio and Perera introduce the notion of outsider anonymous broadcast encryption in [10]. The scheme relies on IBE to encode where a recipient is positioned in a publicly published tree to achieve sublinear ciphertexts. This construction allows sublinear ciphertexts while attaining recipient anonymity to all users that are outside the intended set of receivers.

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