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**CYBER;**  
**Attribute Based Encryption for**  
**Attribute Based Access Control**

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**ETSI**

650 Route des Lucioles  
F-06921 Sophia Antipolis Cedex - FRANCE

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Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B  
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# Contents

Intellectual Property Rights .....	8
Foreword.....	8
Modal verbs terminology.....	8
1 Scope .....	9
2 References .....	9
2.1 Normative references .....	9
2.2 Informative references.....	10
3 Definition of terms, symbols and abbreviations.....	12
3.1 Terms.....	12
3.2 Symbols.....	15
3.3 Abbreviations .....	15
4 Attribute-Based Encryption Toolkit.....	16
4.1 CPA-secure ciphertext-policy and key-policy attribute-based key-encapsulation mechanisms.....	16
4.1.1 Overview .....	16
4.1.2 Ciphertext-policy ABKEM.....	16
4.1.3 Key-policy ABKEM .....	17
4.2 Specifications of CPA-secure ciphertext-policy and key-policy ABKEMs .....	17
4.2.1 General.....	17
4.2.1.1 Introduction.....	17
4.2.1.2 Random bit generation.....	18
4.2.1.3 Formats for attributes and policies.....	18
4.2.1.4 The map2point mapping .....	18
4.2.1.4.1 General .....	18
4.2.1.4.2 map2point_34.....	18
4.2.1.4.3 map2point_ssing23.....	19
4.2.1.4.4 map2point_23.....	19
4.2.1.5 Monotone span programs.....	20
4.2.1.5.1 General .....	20
4.2.1.5.2 MSP_Encode .....	20
4.2.1.5.3 MSP_Decode.....	21
4.2.2 Specification of CP-WATERS-KEM .....	22
4.2.2.1 General .....	22
4.2.2.2 Setup .....	22
4.2.2.3 Secret-key generation.....	22
4.2.2.4 Symmetric-key encapsulation .....	23
4.2.2.5 Symmetric-key decapsulation .....	24
4.2.3 Specification of CP-FAME-KEM and KP-FAME-KEM .....	24
4.2.3.1 Hash functions.....	24
4.2.3.2 Setup for CP-FAME-KEM and KP-FAME-KEM .....	25
4.2.3.3 CP-FAME-KEM .....	26
4.2.3.3.1 General .....	26
4.2.3.3.2 Secret-key generation .....	26
4.2.3.3.3 Symmetric-key encapsulation.....	27
4.2.3.3.4 Symmetric-key decapsulation.....	27
4.2.3.4 KP-FAME-KEM.....	28
4.2.3.4.1 General .....	28
4.2.3.4.2 Secret-key generation .....	28
4.2.3.4.3 Symmetric-key encapsulation.....	29
4.2.3.4.4 Symmetric-key decapsulation.....	30
4.2.4 Specification of KP-GSPW-KEM .....	30
4.2.4.1 General .....	30
4.2.4.2 Setup .....	31
4.2.4.3 Secret-key generation.....	31
4.2.4.4 Symmetric-key encapsulation .....	32

4.2.4.5	Symmetric-key decapsulation .....	32
4.3	Ciphertext-Policy and Key-Policy Attribute-Based Encryption.....	33
4.3.1	Overview .....	33
4.3.2	Ciphertext-policy ABE .....	33
4.3.3	Key-Policy ABE .....	33
4.4	Specifications of CPA-secure ciphertext-policy and key-policy ABE .....	34
4.4.1	General.....	34
4.4.1.1	Introduction.....	34
4.4.1.2	Pseudorandom generator .....	34
4.4.2	CPA-secure CP-ABE.....	34
4.4.3	CPA-secure KP-ABE scheme.....	35
4.5	Specifications of CCA-secure CP-ABKEMs and KP-ABKEMs, CP-ABE schemes and KP-ABE schemes .....	36
4.5.1	General.....	36
4.5.1.1	Introduction.....	36
4.5.1.2	Collusion-resistant hash function .....	36
4.5.1.3	Authenticated encryption .....	36
4.5.2	CCA-secure CP-ABKEM .....	36
4.5.3	CCA-secure KP-ABKEM.....	37
4.5.4	CCA-secure CP-ABE .....	38
4.5.5	CCA-secure KP-ABE .....	38
4.6	Requirements for compliant ABKEMs .....	39
4.6.1	General.....	39
4.6.2	Requirement 1: correctness and indistinguishability under chosen-plaintext attacks for ABKEMs..	39
4.6.2.1	Correctness.....	39
4.6.2.2	Indistinguishability under chosen-plaintext attacks .....	40
4.6.3	Requirement 2: Sufficient security levels .....	41
4.7	Revocation.....	41
4.7.1	Attribute revocation .....	41
4.7.2	Secret-key revocation .....	41
4.8	Recommendations .....	41
4.8.1	Overview .....	41
4.8.2	Efficiency considerations .....	42
4.8.3	Security considerations .....	42
5	Trust models.....	42
5.1	Overview .....	42
5.2	Roles.....	42
5.2.1	Data Consumer .....	42
5.2.2	Data Controller .....	42
5.2.3	Data Processor .....	43
5.2.4	Data Subject.....	43
5.2.5	Device manager .....	43
5.2.6	Platform Provider (PP).....	43
5.2.7	Third Party Service Provider (3SP) .....	43
5.2.8	Platform User (Pu).....	43
5.3	Models.....	43
5.3.1	Long term storage .....	43
5.3.2	Offline access control .....	44
5.3.3	Platform Provider.....	45
5.4	Functions .....	46
5.4.1	Authority function .....	46
5.4.2	Assertion function.....	46
5.4.2.1	General .....	46
5.4.2.2	Data access assertion.....	46
5.4.2.3	Data capture assertion .....	46
5.4.3	Encryption function .....	46
5.4.4	Policy Management function .....	47
5.4.5	Key distribution function.....	47
5.4.6	Decryption function .....	47
6	Procedures for distributing attributes and keys .....	47

6.1	Introduction .....	47
6.2	Platform Provider extended with Public Key Infrastructure X.509.....	48
6.2.1	Overview .....	48
6.2.2	Entities .....	48
6.2.2.1	Introduction .....	48
6.2.2.2	ABE Authority (ABEA).....	48
6.2.2.3	Keys associated to the Third Party Service Provider (3SP) .....	49
6.2.2.4	Keys associated to the Platform Provider (PP) .....	49
6.2.3	ABE Key Distribution .....	49
6.2.3.1	General .....	49
6.2.3.2	Setup .....	49
6.2.3.3	ABE Public Key distribution.....	50
6.2.3.4	ABE secret key material distribution .....	50
6.2.3.5	Attributes distribution .....	50
6.2.4	ABE Public Key revocation.....	50
6.3	Assertions .....	50
6.3.1	Introduction.....	50
6.3.2	Types of assertions.....	50
6.3.3	Mapping to SAML.....	51
6.3.3.1	SAML Attributes.....	51
6.3.3.2	SAML Attribute Statements.....	51
6.3.3.2.1	Unencrypted format.....	51
6.3.3.2.2	Encrypted format .....	52
6.3.3.3	SAML Attribute Queries.....	52
6.3.3.4	Key assertions .....	52
6.3.3.5	Security considerations .....	52
6.3.4	SAML binding for CoAP.....	52
6.3.4.1	Message encapsulation.....	52
6.3.4.2	Addressing and intermediaries.....	52
6.3.4.3	Security .....	53
7	Attribute Based Access Control layer.....	53
7.1	Overview .....	53
7.2	Base ABKEM access control capabilities ("Layer 1").....	53
7.2.1	Introduction.....	53
7.2.2	Attributes .....	53
7.2.2.1	Syntax for attribute declaration .....	53
7.2.2.2	Attribute types.....	54
7.2.2.3	Syntax for ABKEM universe declaration .....	54
7.2.2.4	Syntax for value assignment in annotations .....	54
7.2.3	Policies.....	55
7.2.3.1	General definition of a policy and syntax .....	55
7.2.3.2	Relational statements .....	55
7.2.3.2.1	Introduction .....	55
7.2.3.2.2	Relational operators for the unsigned integer attribute type .....	55
7.2.3.2.3	Relational operators for the boolean attribute type.....	56
7.2.3.2.4	Relational operators for the string attribute type .....	56
7.2.3.3	Logical operators.....	56
7.2.3.4	Threshold gates .....	56
7.2.3.5	Top-level statements .....	57
7.2.4	ABKEM bindings .....	57
7.2.4.1	Introduction.....	57
7.2.4.2	Binding rules for value assignment to attributes in annotation .....	57
7.2.4.2.1	Common translation rules.....	57
7.2.4.2.2	Unsigned integer.....	57
7.2.4.2.3	Boolean.....	58
7.2.4.2.4	String .....	58
7.2.4.3	Binding rules for policy translation.....	58
7.2.4.3.1	Common translation rules.....	58
7.2.4.3.2	Integer.....	59
7.2.4.3.3	Boolean.....	62
7.2.4.3.4	String .....	62

7.3	Intermediate access control layer ("Layer 2") .....	63
7.3.1	Introduction (informative) .....	63
7.3.2	Additional attribute types.....	63
7.3.2.1	Double.....	63
7.3.2.1.1	Definition.....	63
7.3.2.1.2	Relational operators for doubles.....	63
7.3.2.2	Time measurement.....	63
7.3.2.2.1	Timestamp.....	63
7.3.2.2.2	Duration.....	64
7.3.2.2.3	Cycles.....	65
7.3.2.3	Location.....	66
7.3.2.3.1	Zone.....	66
7.3.2.3.2	Grid.....	66
7.3.2.3.3	1d point.....	67
7.3.2.3.4	2d point.....	67
7.3.2.3.5	3d point.....	68
7.3.2.3.6	Circle perimeter.....	69
7.3.2.3.7	Sphere surface.....	70
7.3.2.4	Abstract string types.....	71
7.3.2.4.1	Free string.....	71
7.3.2.4.2	Clearance.....	71
7.3.2.4.3	Role.....	72
7.3.2.4.4	User.....	72
7.3.2.4.5	Device.....	72
7.3.2.4.6	Function.....	73
7.3.2.4.7	Datatype.....	73
7.3.2.4.8	Origin.....	73
7.3.3	Support for foreign data types.....	74
7.3.3.1	Introduction.....	74
7.3.3.2	Datatypes identified in annex C.....	74
7.3.3.2.1	Primitive data types from XML Schema.....	74
7.3.3.2.2	Time data types from XML Schema.....	74
7.3.3.2.3	Resource identifiers.....	75
7.4	ABKEM operations.....	75
7.4.1	General.....	75
7.4.2	Time-based implicit secret key revocation.....	75
7.4.2.1	Implementation in KP-ABKEM.....	75
7.4.2.2	Implementation in CP-ABKEM.....	75
7.4.3	Counter-based implicit secret key revocation.....	76
7.4.3.1	Implementation in KP-ABKEM.....	76
7.4.3.2	Implementation in CP-ABKEM.....	76
7.4.4	Simple Mandatory access control.....	77
7.4.4.1	Implementation in KP-ABKEM.....	77
7.4.4.2	Implementation in CP-ABKEM.....	77
7.4.5	Role-based access control.....	77
7.4.5.1	Implementation in KP-ABKEM.....	77
7.4.5.2	Implementation in CP-ABKEM.....	77
7.4.6	Location-based access control (informative).....	78
7.4.7	Reduced access control based on the emergency level.....	79
7.4.7.1	Implementation in KP-ABKEM.....	79
7.4.7.2	Implementation in CP-ABKEM.....	79
7.4.8	Access control based on service tier.....	80
7.4.8.1	Implementation in KP-ABKEM.....	80
7.4.8.2	Implementation in CP-ABKEM.....	80
7.5	Translation rules for XACML.....	80
7.5.1	Introduction (informative).....	80
7.5.2	General requirements.....	80
7.5.3	Implementation in KP-ABKEM.....	81
7.5.3.1	KP-ABKEM specific requirements.....	81
7.5.3.2	Issuance of secret keys.....	81
7.5.3.3	Processing of Permission <PolicySet> element.....	81
7.5.4	Implementation in CP-ABKEM.....	82

7.5.4.1	CP-ABKEM specific requirements .....	82
7.5.4.2	Preparation of policies for ciphertexs.....	82
7.5.4.3	Processing of Permission <PolicySet> element .....	82
7.5.4.4	Encapsulation into ciphertext .....	82
7.5.5	Combining algorithms and functions.....	83
7.6	Authentication using ABKEM .....	84
7.6.1	Introduction.....	84
7.6.2	Principles .....	84
7.6.3	Common messages .....	86
7.6.3.1	Resource identification.....	86
7.6.3.2	Claimant identification.....	86
7.6.4	Implementation in KP-ABKEM .....	86
7.6.5	Implementation in CP-ABKEM .....	86
<b>Annex A (informative):</b>	<b>ABE schemes from the cryptographic literature .....</b>	<b>87</b>
<b>Annex B (informative):</b>	<b>Applicable features of traditional ABAC .....</b>	<b>89</b>
<b>Annex C (informative):</b>	<b>Common semantics .....</b>	<b>90</b>
C.1	Introduction .....	90
C.2	Primitive data types .....	90
C.3	Time .....	90
C.4	Location.....	91
C.5	Identifiers for resources.....	91
C.6	Domain specific ontologies .....	91
C.6.1	Introduction .....	91
C.6.2	OneM2M Base Ontology .....	92
C.6.3	ISO/IEC 19944.....	92
<b>Annex D (normative):</b>	<b>Grammars for the attribute based access control layer .....</b>	<b>93</b>
D.1	Introduction .....	93
D.2	Universe and attribute declarations .....	93
D.3	Policy declarations .....	94
D.4	Attribute assignments at Layer 1 .....	95
D.5	ABKEM attribute encoding.....	95
<b>Annex E (informative):</b>	<b>Bibliography.....</b>	<b>96</b>
History .....		97

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## Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Cyber Security (CYBER).

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# 1 Scope

The present document specifies trust models, functions and protocols using attribute based encryption as a foundation of an attribute based access control scheme. It covers both the Ciphertext-Policy (CP-ABE) and Key-Policy (KP-ABE) variants of Attribute-Based Encryption.

The specifications address the following aspects:

- Identification of an ABE scheme covering both the Ciphertext-Policy and Key-Policy variants.
- Definition of interactions between the data sources, the service providers and the authority releasing attributes and key material.
- Mechanisms for keys, policies, and attributes distribution.
- Mechanisms for secret key expiration and revocation.
- Definition of semantics for a basic set of attributes to ensure interoperability.
- Mapping to a standard Public Key Infrastructure X.509.
- Mapping to a standard assertion protocol (SAML).
- Definition of a policy schema for data access control.
- Identification of limitations compared to traditional ABAC features.
- Translation rules to XACML.
- Definition of new protocol bindings when existing bindings do not cover the deployment scenario (e.g. a CoAP binding for the IoT case).

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- [1] Bureau international des poids et mesures: "The International System of Units (SI)".
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- [i.1] ISO/IEC 29100:2011: "Information technology - Security techniques - Privacy framework".
- [i.2] National Institute of Standards and Technology NIST SP 800-122: "Guide to Protecting the Confidentiality of Personally Identifiable Information (PII)".
- [i.3] ETSI TS 103 458: "CYBER; Application of Attribute Based Encryption (ABE) for PII and personal data protection on IoT devices, WLAN, cloud and mobile services - High level requirements".
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## 3 Definition of terms, symbols and abbreviations

### 3.1 Terms

For the purposes of the present document, the following terms apply:

**ABE authority:** ABE entity that stores the master secret key and gives out secret keys

**ABKEM universe:** set of attributes in which the number of attributes can be a linear (small-universe) or exponential (large-universe) function of the system's security strength

**ABKEM universe regeneration:** procedure by which an entirely new ABKEM universe is generated, with redistribution of new public key, new master secret key and new secret keys

**app:** "software application", typically running on a user's device platform

**assertion:** statement made by an authority about a property of an entity, typically for - but not restricted to - access control decisions

**asymmetric encryption system:** encryption system based on asymmetric cryptographic techniques whose public transformation is used for encryption and whose private transformation is used for decryption

NOTE: See ISO/IEC 18033-1 [i.17].

**attack:** algorithm that performs computations and makes queries to the encryption algorithm for the encryption and/or for the decryption of adaptively chosen texts under a single secret key, with the purpose of recovering either the unknown plaintext for a given ciphertext, which may be adaptively chosen but for which a decryption query is not issued or a secret key

NOTE: See ISO/IEC 18033-1 [i.17].

**attack cost:** ratio of the average complexity of the attack algorithm measured in terms of the number of calls to the encryption algorithm made by the attack to the probability of success of the attack

NOTE: See ISO/IEC 18033-1 [i.17].

**attribute:** characteristic or property of an entity that can be used to describe its state, appearance or other aspects

NOTE: See ISO/IEC 24760-1 [i.19].

**Attribute-Based Encryption (ABE) system:** asymmetric encryption system which is either a CP-ABE system, a KP-ABE system or a combination of both

**attribute universe:** set of attributes

**cloud platform provider:** cloud service provider providing identity management services and interfaces (e.g. API, marketplace, etc.) for third party applications using the platform services

**cloud platform user:** cloud service user consuming one or more platform services

**cloud service customer:** individual or organization consuming one or more cloud services provided by a cloud service provider

**cloud service partner:** individual or organization providing support to the provisioning of cloud services by the cloud service provider, or to the consumption of cloud service by the cloud service customer

**cloud service provider:** individual or organization providing cloud services to one or more cloud service customers

**cloud service user:** individual consuming one or more cloud services using a particular device

**ciphertext:** data which has been transformed to hide its information content

NOTE: See ISO/IEC 18033-1 [i.17].

**Ciphertext-Policy Attribute-Based Encryption (CP-ABE) system:** asymmetric encryption system where secret keys are derived from a set of attributes and ciphertexts are derived from a policy on attributes

**data consumer:** natural or legal person, public authority, agency or any other body accessing data for a given purpose

**data controller:** natural or legal person, public authority, agency or any other body which alone or jointly with others determines the purposes and means of the processing of personal data

**data processor:** natural or legal person, public authority, agency or any other body which processes personal data on behalf of the controller

**data subject:** identifiable person, i.e. a person who can be identified, directly or indirectly, in particular by reference to an identification number or to one or more factors specific to his physical, physiological, mental, economic, cultural or social identity

**decryption:** reversal of a corresponding encryption

NOTE: See ISO/IEC 18033-1 [i.17].

**decryptor:** entity which decrypts ciphertexts

NOTE: See ISO/IEC 18033-1 [i.17].

**encryption:** (reversible) transformation of data by a cryptographic algorithm to produce a ciphertext, i.e. to hide the information content of the data

NOTE: See ISO/IEC 18033-1 [i.17].

**encryptor:** entity which encrypts ciphertexts

NOTE: See ISO/IEC 18033-1 [i.17].

**entity:** item inside or outside an information and communication technology system, such as a person, an organization, a device, a subsystem or a group of such items that has recognizable distinct existence

NOTE: See ISO/IEC 24760-1 [i.19].

**home network:** central source for mobility services to the subscriber. The subscriber has a direct subscription with the home network

**identity:** set of attributes related to an entity

NOTE: See ISO/IEC 24760-1 [i.19].

**Key-Policy Attribute-Based Encryption (KP-ABE) system:** asymmetric encryption system where ciphertexts are derived from a set of attributes and secret keys are derived from a policy on attributes

**match:** policy statement in the access structure is said to match when the attributes in the annotation allow said statement to be evaluated to true in the logical sense

**master public key:** public value uniquely determined by the corresponding master secret key

NOTE: See ISO/IEC 18033-5 [i.18].

**master secret key:** secret value used by the secret key generator to compute secret keys for an ABE mechanism

**personal data:** any information relating to an identified or identifiable natural person ('data subject')

**Personally Identifiable Information (PII):** any information that:

- a) can be used to identify the PII principal to whom such information relates; or
- b) is or might be directly or indirectly linked to a PII principal.

NOTE 1: To determine whether a PII principal is identifiable, account can be taken of all the means which can reasonably be used by the privacy stakeholder holding the data, or by any other party, to identify that natural person (ISO/IEC 29100 [i.1]).

**NOTE 2:** In the US, according to NIST SP 800-122 [i.2], any information about an individual maintained by an agency, including any information that can be used to distinguish or trace an individual's identity, such as name, social security number, date and place of birth, mother's maiden name, or biometric records; and any other information that is linked or linkable to an individual, such as medical, educational, financial, and employment information.

**PII controller:** privacy stakeholder that determines the purposes and means for processing personally identifiable information (PII) other than natural persons who use data for personal purposes

**NOTE:** See ISO/IEC 29100:2011 [i.1].

**PII principal:** natural person to whom the personally identifiable information (PII) relates

**NOTE:** See ISO/IEC 29100:2011 [i.1].

**PII processor:** privacy stakeholder that processes personally identifiable information (PII) on behalf of and in accordance with the instructions of a PII controller

**NOTE:** See ISO/IEC 29100:2011 [i.1].

**plaintext:** unencrypted information

**NOTE:** See ISO/IEC 18033-1 [i.17].

**platform Provider:** service provider providing services necessary to support a platform

**secret key generator:** entity or function which generates a set of secret keys

**NOTE:** See ISO/IEC 18033-5 [i.18].

**policy on attributes:** boolean predicate on attributes combining equality and/or inequality tests

**policy statement:** elementary test in an access control policy (e.g. "A < B")

**processing of PII:** operation or set of operations performed upon personally identifiable information (PII)

**NOTE 1:** See ISO/IEC 29100:2011 [i.1].

**NOTE 2:** Examples of processing operations of PII include, but are not limited to, the collection, storage, alteration, retrieval, consultation, disclosure, anonymization, pseudonymization, dissemination or otherwise making available, deletion or destruction of PII [i.1].

**random tape:** source of (pseudo-)random bits

**security strength:** number associated with the amount of work (e.g. the number of operations) that is required to break a cryptographic algorithm or system

**NOTE:** See ISO/IEC 18033-1 [i.17].

**serving network:** home network or visited network the user equipment is connected to

**set up:** process by which the system parameters of an ABE mechanism are selected

**set up algorithm:** process which generates a master secret key and the corresponding master public key, together with some part of the system parameters

**NOTE:** See ISO/IEC 18033-5 [i.18].

**setup party:** entity that specifies the security parameter and handles the setup of the ABE and ABKEM system

**subscriber User Equipment (UE):** any device allowing a user access to network services

**system parameters:** parameters for cryptographic computation including a selection of a particular cryptographic scheme or function from a family of cryptographic schemes of functions, or from a family of mathematical spaces

**NOTE:** See ISO/IEC 18033-5 [i.18].

**top-level policy statement:** policy statement that is evaluated in all branches of the access structure

**trust:** level of confidence in the reliability and integrity of an entity to fulfil specific responsibilities

**Trusted Authority (TA):** ABE authority entitled to generate the public key PK and the corresponding secret keys according to a selected large universe ABE scheme

**visited network:** any network that interacts with the home network to provide mobility services to the subscriber terminal

## 3.2 Symbols

Void.

## 3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

3SP	Third Party Service Provider
AAD	Additional Authentic Data
ABAC	Attribute-Based Access Control
ABE	Attribute-Based Encryption
ABEA	Attribute-Based Encryption Authority
ABFN	Augmented Backus-Naur Form
ABKEM	Attribute-Based Key-Encapsulation Mechanism
ABNF	Augmented Backus-Naur Form
AE	Authenticated Encryption
AES	Advanced Encryption Standard
AP	Access Policy
API	Application Programming Interface
ASCII	American Standard Code for Information Interchange
BDH	Bilinear Diffie-Hellman
CA	Certification Authority
C <sub>AE</sub>	Ciphertext for Authenticated Encryption
CCA	Chosen-Ciphertext Attack
CP	Ciphertext Policy
CPA	Chosen-Plaintext Attack
CP-ABE	Ciphertext Policy ABE
CP-ABKEM	Ciphertext Policy ABKEM
CRL	Certificate Revocation List
DBDDH	Decisional Bilinear DDH
DBDHE	Decisional Bilinear Diffie-Hellman Exponent
DDH	Decisional Diffie-Hellman
DNS	Domain Name System
DPP	Device Platform Provider
ECDSA	Elliptic Curve Digital Signature Algorithm
GGM	Generic Group Model
GML	Geography Markup Language
IBBE	Identity-Based Broadcast Encryption
IP	Internet Protocol
K <sub>AE</sub>	Symmetric Key for Authenticated Encryption
KEM	Key Encapsulation Mechanism
KP	Key-Policy
KP-ABE	Key Policy ABE
KP-ABKEM	Key Policy ABKEM
LO	IETF GeoPriv Location Object
MEBDH	Multi-Exponent BDH
MPK	Master Public Key
MSK	Master Secret Key
MSP	Monoton Span Program
NIST	National Institute of Standards and Technology
OR	OR (bitwise operator)