Introduction to MPTS 2023

Presented* on September 26th @ MPTS 2023 (Virtual)

NIST Workshop on **M**ulti-**P**arty **T**hreshold **S**chemes 2023

Hosted by the Cryptographic Technology Group @ NIST
National **I**nstitute of **S**tandards and **T**echnology

* Luís Brandão (NIST/Strativia: Foreign Guest Researcher [non-employee] at NIST, contractor from Strativia). Expressed opinions are those of the speaker/author and should not be construed as official views of NIST.

Outline

1. High-level context: MPTC, PEC, the Threshold Call

2. MPTS 2023 (schedule, topics, statistics)

3. Online resources

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Two NIST-Crypto projects related to today's event

(i.e., projects in the Cryptographic Technology Group at NIST)

- **MPTC:** "**multi-party threshold cryptography**" (threshold schemes for crypto primitives)
- **PEC:** "**privacy-enhancing cryptography**" (advanced features/functionalities)

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- **MPTC:** "**multi-party threshold cryptography**" (threshold schemes for crypto primitives)
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The "Threshold Call" (from MPTC+PEC):

NIST First Call for Multi-Party Threshold Schemes

[see NISTIR 8214C] to gather **reference material** for public analysis ...

aiming for **recommendations** (in a 1st phase), including about PEC.

NIST Call for Multi-Party Threshold Schemes

- NISTIR 8214C: Initial public **draft** (**Jan 2023**) ⇒ Revised version (**late 2023**).
- Submission deadline (expected ≈ **2nd-half 2024**)

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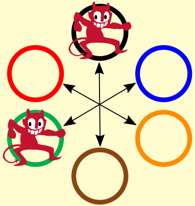

Calling for submissions of threshold schemes

(And gadgets for modular use)

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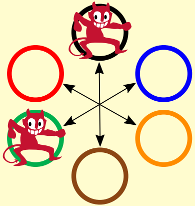

Calling for submissions of threshold schemes for:

- **[Cat1] Selected NIST-standardized primitives**
- **[Cat2] Other primitives (including FHE, IBE/ABE, ZKP)**

  (And gadgets for modular use)

FHE = Fully-homomorphic encryption.

IBE/ABE = Identity/Attribute-based encryption.

ZKP = Zero-knowledge proof.

Main components of a submission package

Check	#	Item
□	M1	Written specification (S1–S16)
□	M2	Reference implementation (Src1–Src4)
□	M3	Execution instructions (X1–X7)
□	M4	Experimental evaluation (Perf1–Perf5)
□	M5	Additional statements

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The revised version of the call will detail better each **component**.

A submission package can propose various **objects** (schemes/gadgets).

Each **component** will then map all such **objects**.

Selected notes about the "Threshold Call"

1. It has a **wide scope** of subcategories for submission (next slides)
2. Enables an **exploration** of advanced cryptography, before promising standards
3. The initial process will devise **recommendations** for subsequent processes
4. Both **post-and-pre quantum** primitives are in scope.
5. **Active security** is required, though open to diverse security formulations.
6. **Modularity** is strongly encoraged (gadgets)
7. Community **participation** is essential (feedback; submissions; analyses)

Category Cat1 of NIST Call for Multi-Party Threshold Schemes

Subcategory: Type	**Families of specifications**
C1.1: **Signing** (preQ)	EdDSA sign, ECDSA sign, RSADSA sign
C1.2: **PKE** (preQ)	RSA decrypt, RSA encrypt (a secret value)
C1.3: **2KA**	ECC-CDH, ECC-MQV
C1.4: **Symmetric**	AES encipher/decipher, KDM/KC (for 2KE)
C1.5: **Keygen**	ECC keygen, RSA keygen, bitstring keygen

Too many acronyms, we know. **Legend:** **2KA**: pair-wise key-agreement. **2KE**: pair-wise key-establisment. **AEAD** = Authenticated Encryption with Associated Data. **AES**: Advanced Encryption Standard. **CDH**: cofactor Diffie–Hellman. **DSA** = Digital Signature Algorithm. **ECC**: Elliptic-curve cryptography (or, if used as an adjective, EC-based). **ECDSA**: Elliptic-curve Digital Signature Algorithm. **EdDSA**: Edwards-curve Digital Signature Algorithm. Elliptic-curve based Key-Establishment. **KC**: Key-confirmtion. **KDM**: Key-derivation mechanism. **KEM**: Key-Encapsulation Mechanism. **Keygen**: Key-generation. **ML** = Module Lattice. **MQV**: Menezes-Qu-Vanstone. **PKE**: public-key encryption. **postQ**: Post-Quantum. **preQ**: Pre-Quantum. **RSA**: Rivest–Shamir–Adleman (signature and encryption schemes). **RSADSA**: RSA digital signature algorithm. **SLH** = StateLess hash. **XOF** = extendable Output Function. **Note:** In the 2nd column, each item within a subcategory is itself called a family of specifications, since it may include diverse primitives or modes/variants.

Category Cat1 of NIST Call for Multi-Party Threshold Schemes

Subcategory: Type	**Families of specifications**
C1.1: **Signing** (preQ) (postQ)	EdDSA sign, ECDSA sign, RSADSA sign ML-DSA, SLH-DSA, FN-DSA
C1.2: **PKE** (preQ) (postQ)	RSA decrypt, RSA encrypt (a secret value) ML-KEM
C1.3: **2KA**	ECC-CDH, ECC-MQV
C1.4: **Symmetric**	AES encipher/decipher, KDM/KC (for 2KE) [upcoming] ("lightweight") ASCON-related AEAD and XOF
C1.5: **Keygen**	ECC keygen, RSA keygen, bitstring keygen

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Category Cat2 of the NIST "Threshold" Call

TF = **t**hreshold **f**riendly. QR = **q**uantum **r**esistant.

Subcategory: Type	**Example types of schemes**	**Example primitives**
C2.1: **Signing**	TF succinct & verifiably-deterministic signatures	Sign
|	TF-QR signatures	Sign
C2.2: **PKE**	TF-QR **p**ublic-**k**ey **e**ncryption (PKE)	Decrypt/Encrypt (a secret value)
C2.3: **Key-agreem.**	TF Low-round multi-party key-agreement	Single-party primitives
C2.4: **Symmetric**	TF blockcipher/PRP	Encipher/decipher
|	TF key-derivation / key-confirmation	PRF and hash function
C2.5: **Keygen**	Any of the above	Keygen

Note: While TF-QR is desired for any type of scheme, some examples show just TF to highlight that it is welcome even if not QR.

Legend: **agreem.** = **agreem**ent. **Keygen** = **key-gen**eration. **PKE** = **p**ublic-**k**ey **e**ncryption. **PRF** = **p**seudo**r**andom **f**unction [family]. **PRP** = **p**seudo**r**andom **p**ermutation [family]. **QR** = **q**uantum **r**esistant. **TF** = **t**hreshold-**f**riendly. **ZKPoK** = **z**ero **k**nowledge **p**roof **o**f **k**nowledge.

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|	TF-QR signatures	Sign
C2.2: **PKE**	TF-QR **p**ublic-**k**ey **e**ncryption (PKE)	Decrypt/Encrypt (a secret value)
C2.3: **Key-agreem.**	TF Low-round multi-party key-agreement	Single-party primitives
C2.4: **Symmetric**	TF blockcipher/PRP	Encipher/decipher
|	TF key-derivation / key-confirmation	PRF and hash function
C2.5: **Keygen**	Any of the above	Keygen
C2.6: **Advanced**	TF-QR fully-homomorphic encryption	Decryption; Keygen
|	TF identity-based and attribute-based encryption	Decryption; Keygens
C2.7: **ZKPoK**	**Z**ero-**k**nowledge **p**roof **o**f **k**nowledge of private key	ZKPoK.Generate
C2.8: **Gadgets**	Garbled circuit (GC)	GC.generate; GC.evaluate

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Why this workshop (MPTS 2023)

Community feedback and participation are essential!

Thank you in particular (speakers and attendees) for joining MPTS 2023

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What is MPTS 2023?

- "NIST Workshop on Multi-Party Threshold Schemes 2023"
- 3 half-days; ≈ 30 talks; ≈ 300 registered attendees

MPTS 2023 Schedule of Sessions

Date	Session	Time	Session title	# talks
Sep. 26th	—	10:00–10:20	Welcome/Intro to MPTS 2023	—
	1a	10:20–12:00	Generic considerations on MPC/MPTC	4
	1b	13:00–15:00	Threshold Signatures over Elliptic Curves	5
Sep. 27th	**2a**	10:00–12:00	FHE+ZKP+ABE	5
	2b	13:00–14:00	More on Threshold Signatures	3
	2c	14:00–15:00	NIST Standards	4
Sep. 28th	**3a**	10:00–11:40	Some Gadgets	4
	3b	11:40–12:00	Focused Feedback	—
	3c	13:00–14:50	More Gadgets	5
	—	14:50–15:00	Concluding remarks	—

Legend: ABE = **A**ttribute-**b**ased **e**ncryption. FHE = **F**ully-**h**omomorphic **e**ncryption. MPC = (Secure) **M**ulti**p**arty **C**omputation. MPTC = **M**ulti-**p**arty **t**hreshold **c**ryptography. MPTS = **M**ulti-**p**arty **t**hreshold **s**chemes. NIST = **N**ational **I**nstitute of **S**tandards and **T**echnology. Sep. = **Sep**tember. ZKP = **Z**ero-**k**nowledge **p**roof.

Event details: https://csrc.nist.gov/events/2023/mpts2023 **Contact email:** workshop-mpts2023@nist.gov

Suggested Topics in the Call for Presentations

1. **Scope of the Threshold Call:** refinements to the description of subcategories.
2. **Submission requirements** in the Threshold Call: needed clarifications.
3. **Expressions of interest:** intended concrete submissions (and possible submitter team).
4. **Need and adoptability:** special features and primitives useful for specific applications.
5. **Inspiration:** suggestions to the community, for submission of concrete threshold schemes.
6. **Frameworks:** pertinent system models, security formulations, and threshold parameters.
7. **Pre/post quantum:** concrete pre-quantum versus post-quantum cases worth focusing on.
8. **Technicalities:** challenges about concrete primitives / threshold schemes / assumptions.
9. **External efforts:** other processes developing related reference material or specifications.

Video-conference Webinar (registrations and logistics)

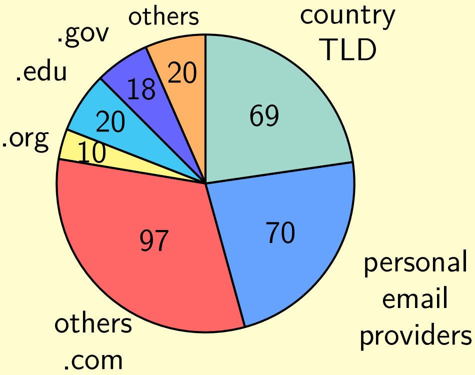
- **Virtual registrations:** 304*
  (Not counting speakers and hosts)

  Across 40 countries: US (124); IN (25); FR (17); CA (16), DE (11), UK (11), IL (9), CN (8), ...

- **Audio and video:** being recorded (posting will be announced in the PEC and MPTC forums)

- **Questions:** Attendees can use the virtual Q&A (to be considered as time permits)

Per registered email address:



*Registrations for 1st day of webinar, as of 8am EDT. Actual number is expected to increase until the workshop starts, and thereafter. Legend: CA = Canada; CN = China; DE = Germany; FR = France; IL = Israel; IN = India; Q&A = Questions and answers; TLD = top-level domain; UK = United Kingdom; US = United States.

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Thank you for your attention!

Introduction to MPTS 2023:

September 26th @ Virtual

We appreciate followup comments: workshop-mpts2023@nist.gov

MPTS 2023
(Sept. 26–28)

Threshold Call
(Draft)

MPTC-Forum
(email list)

PEC-Forum
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