Analyzing the Impact of GDPR on Storage Systems

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General Data Protection Regulation (GDPR)

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Adopted after 2 years of public debate.
All but 2 EU countries have legislated.

Fundamental right

Grants all European people a right to
protection and privacy of personal data

Personal data

Any information relating to a natural person;
Broad in scope unlike FERPA, HIPAA

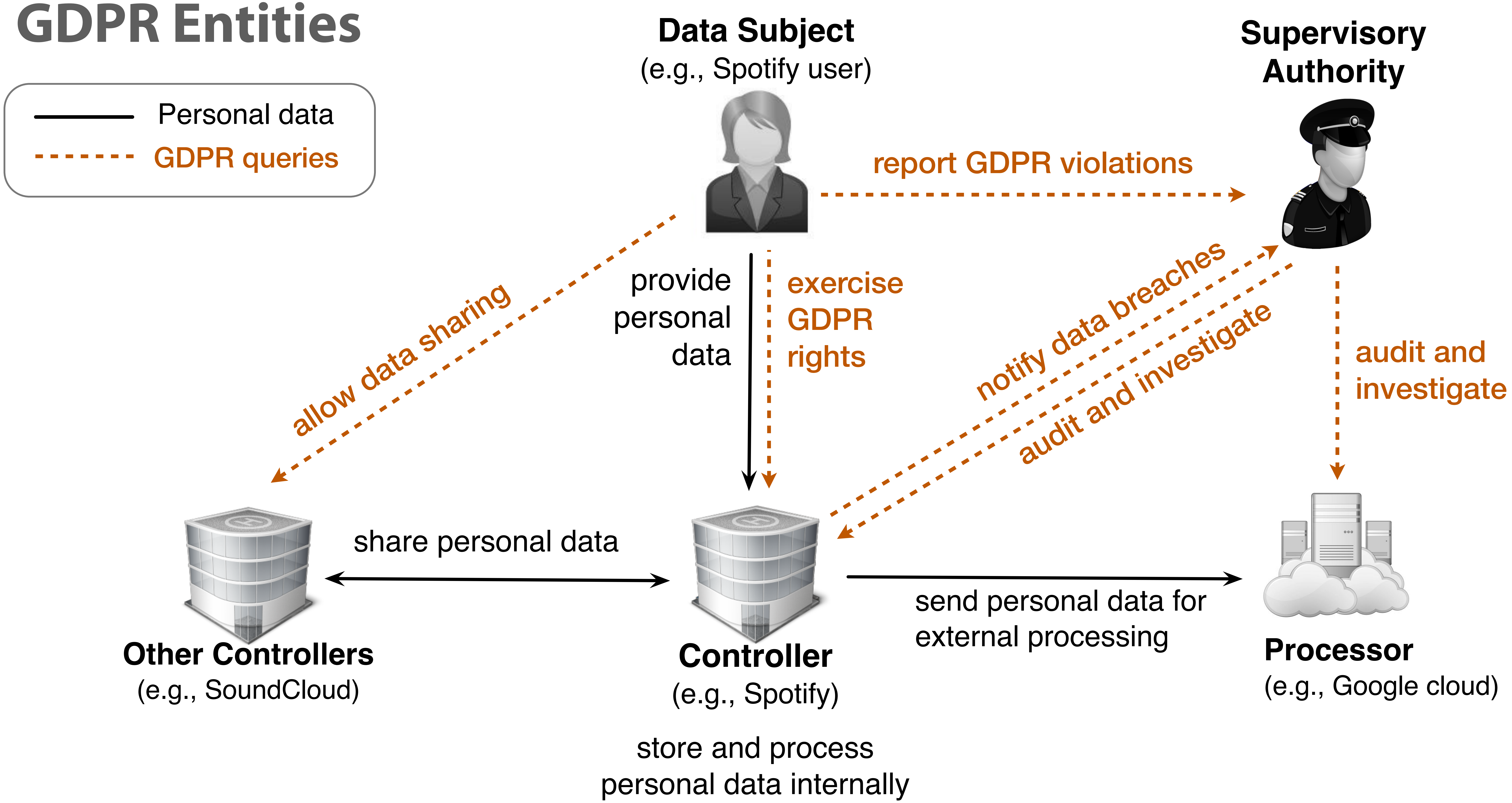
Covers entire lifecycle

Collection, processing, protection, transfer
and deletion; Regulated via 99 articles

Hefty penalty

Max penalty of 4% of global revenue
or €20 million, whichever is greater

GDPR Entities



Personal data

GDPR queries

Data Subject
(e.g., Spotify user)

Supervisory Authority

report GDPR violations

allow data sharing

provide personal data

exercise GDPR rights

notify data breaches

audit and investigate

audit and investigate

Other Controllers
(e.g., SoundCloud)

share personal data

Controller
(e.g., Spotify)

store and process personal data internally

send personal data for external processing

Processor
(e.g., Google cloud)

GDPR in the Wild

Terminated — KLOUT iab.europe

Adapted — USA TODAY The New York Times

Advertised compliance — BigTech

Assumed compliance —

everyone else

<50%

estimated compliance

By the end of 2018 [Gartner 2018]

94,622

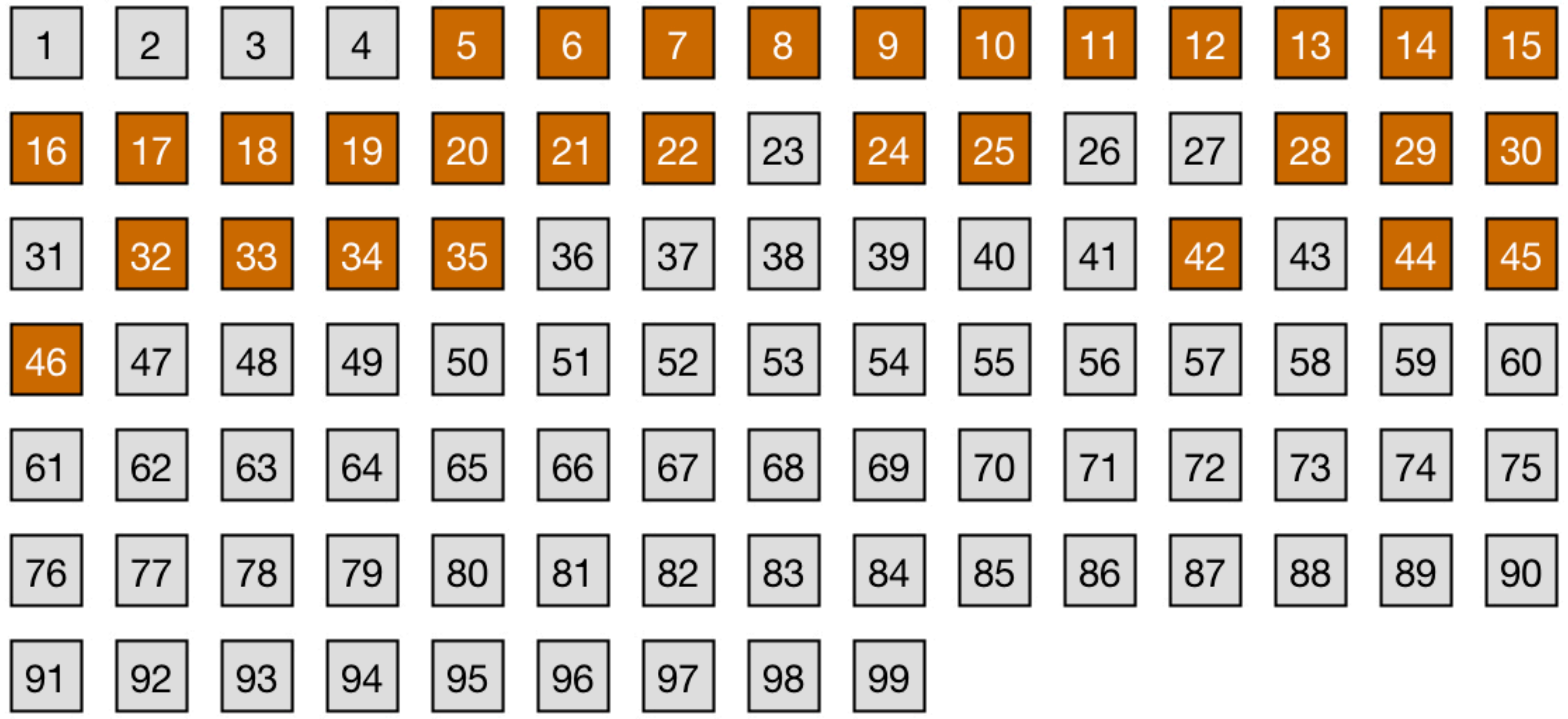
complaints from people

In the first 9 months of GDPR rollout

Analyzing GDPR: *Two Key Observations*

31 of the **99** GDPR articles

directly pertain to storage systems



1	2	3	4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
16	**17**	**18**	**19**	**20**	**21**	**22**	23	**24**	**25**	26	27	**28**	**29**	**30**
31	**32**	**33**	**34**	**35**	36	37	38	39	40	41	**42**	43	**44**	**45**
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99						

GDPR's goal of

data protection by design and by default

conflicts with the traditional system design goals of

performance, cost, and reliability.

Investigate how **GDPR-compliance** impacts **Storage Systems**

- What effort is needed to make a **modern storage** system, GDPR-compliant?
- What is the resulting **performance impact**?
- Is it possible to achieve **strict** compliance in an **efficient** manner?

Key **GDPR Articles** concerning **Storage Systems**

Rights of
data subjects

[15] Right of **Access**

[16] Right to **Rectification**

[17] Right to Be **Forgotten**

[20] Right to **Portability**

[21] Right to **Object**

Responsibilities
of Data Controllers

[5] **Purpose / Storage** limitations

[24] Responsibility of the controller

[25] Protection by **Design** & by **Default**

[30] **Records** of Processing activity

[33] Notification of **Data Breaches**

Translating **GDPR Articles** into **Storage Features**

	GDPR article	Key requirement	Storage feature
13	**Conditions for data collection**	Store metadata associated with personal data	**Metadata management**
17	**Right to be forgotten**	Find and delete groups of data	**Timely deletion**
25	**Protection by design and by default**	Safeguard and restrict access to data	**Encryption, Access control**
30	**Records of processing activity**	Store audit logs of all operations on data	**Logging**

… complete table in the paper

Features of GDPR-Compliant Storage

Timely **deletion**

Associate TTL to all personal data; it can be static value or a policy criterion

Metadata indexing

Provide quick and efficient access to groups of data

Encryption

Encrypt data at rest, and while in transit

Manage data **Location**

Ability to find and control the location of personal data at all times

Access control

Limit access to permitted entities, for established purposes, and for predefined duration of time

Monitoring & **Logging**

Save the audit trail of all internal actions and external interactions

GDPR-Compliance is a Spectrum

Response Time

Real-time

Complete GDPR tasks synchronously in real-time

Eventual

Complete GDPR tasks asynchronously

Capability

Full

Support all GDPR features natively

Partial

Support for some GDPR features is lacking or coarse-grained

GDPR-Compliant **Redis**

*benchmark with **YCSB***

HYPOTHESIS

Despite needing to implement a **small set** of new features for **GDPR**-compliance, storage systems would experience **significant** performance impact.

Redis' support for GDPR features

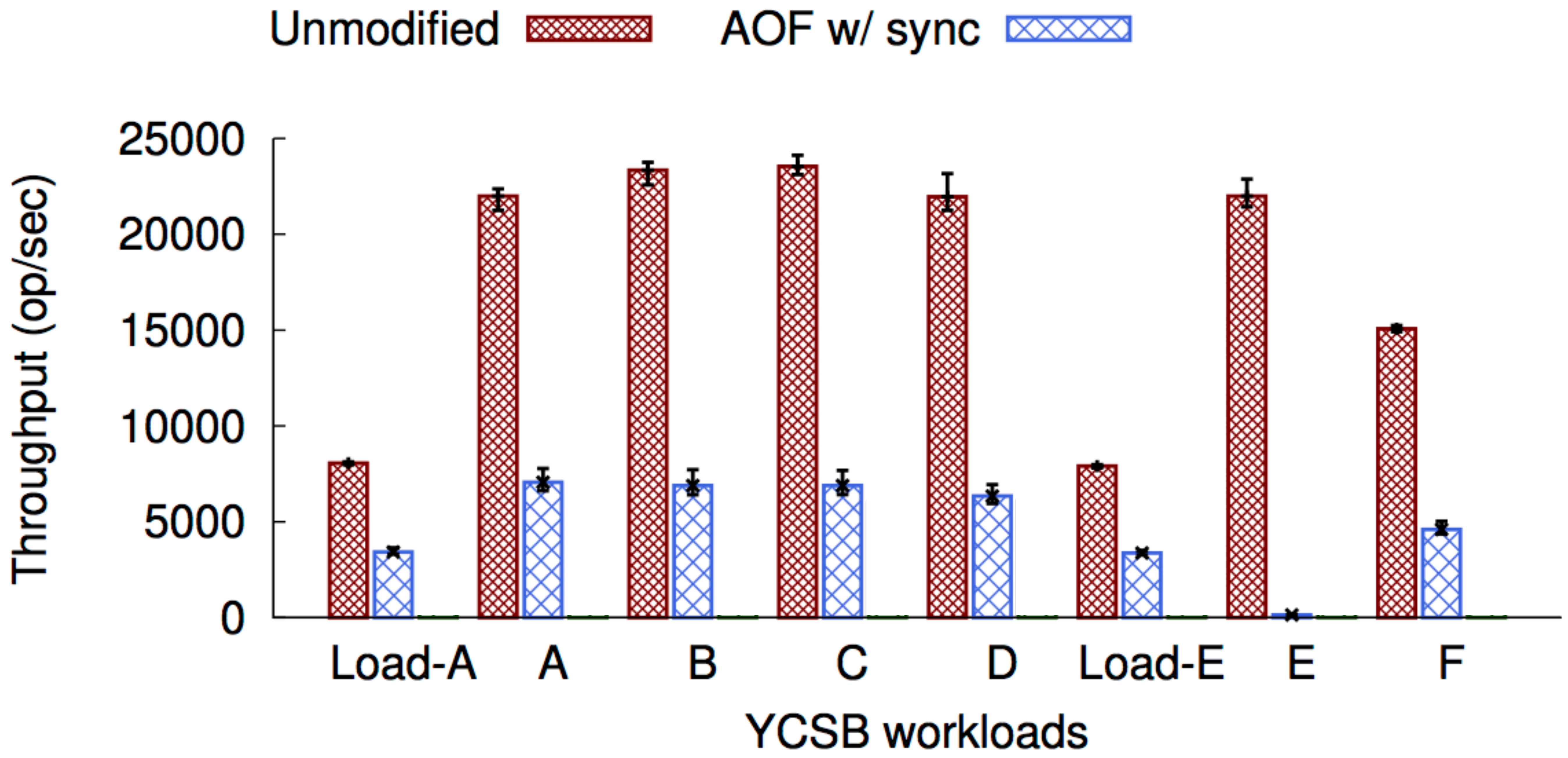
FULL	PARTIAL	NO
Monitoring & Logging	**Timely deletion**	**Encryption**
Manage data Location	Metadata indexing	Access control

GDPR-Compliant Redis: **Monitoring & Logging**

Three built-in options

- **`MONITOR`** debug command
- Configure **`slowlog`** option
- Piggyback on **`AoF`**

modified AoF code to include read/scan operations



Even fully supported features can cause significant **performance overheads**

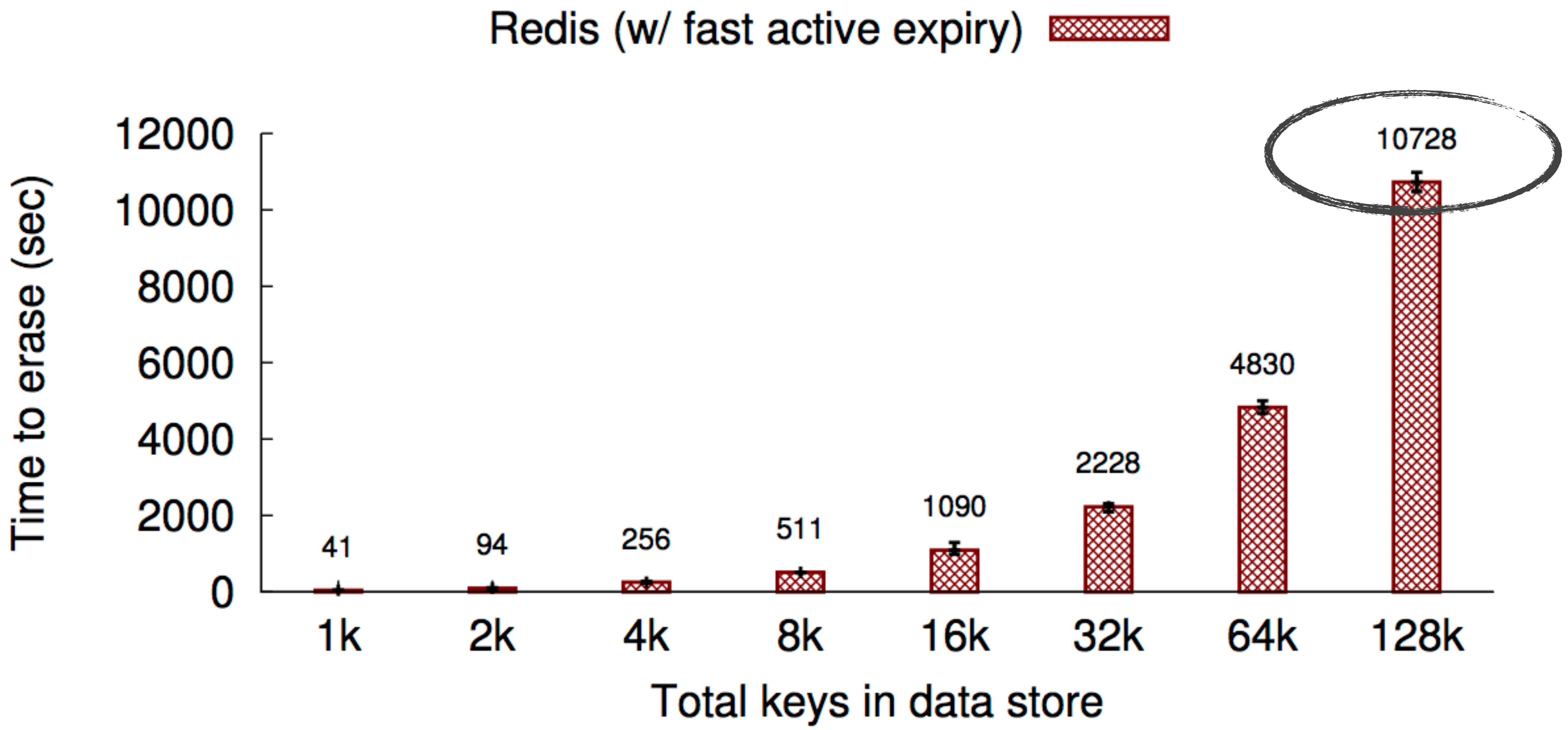
GDPR-Compliant Redis: Timely Deletion

Three options to delete

- **`DEL`** and **`UNLINK`**
- **`FLUSH{DB|ALL}`**
- **`EXPIRE`** and **`EXPIREAT`**

*Redis erases expired keys using **a lazy randomized algorithm***

*We changed it to a **static** scheme (== **sub-second** latency for up to 1M keys)*



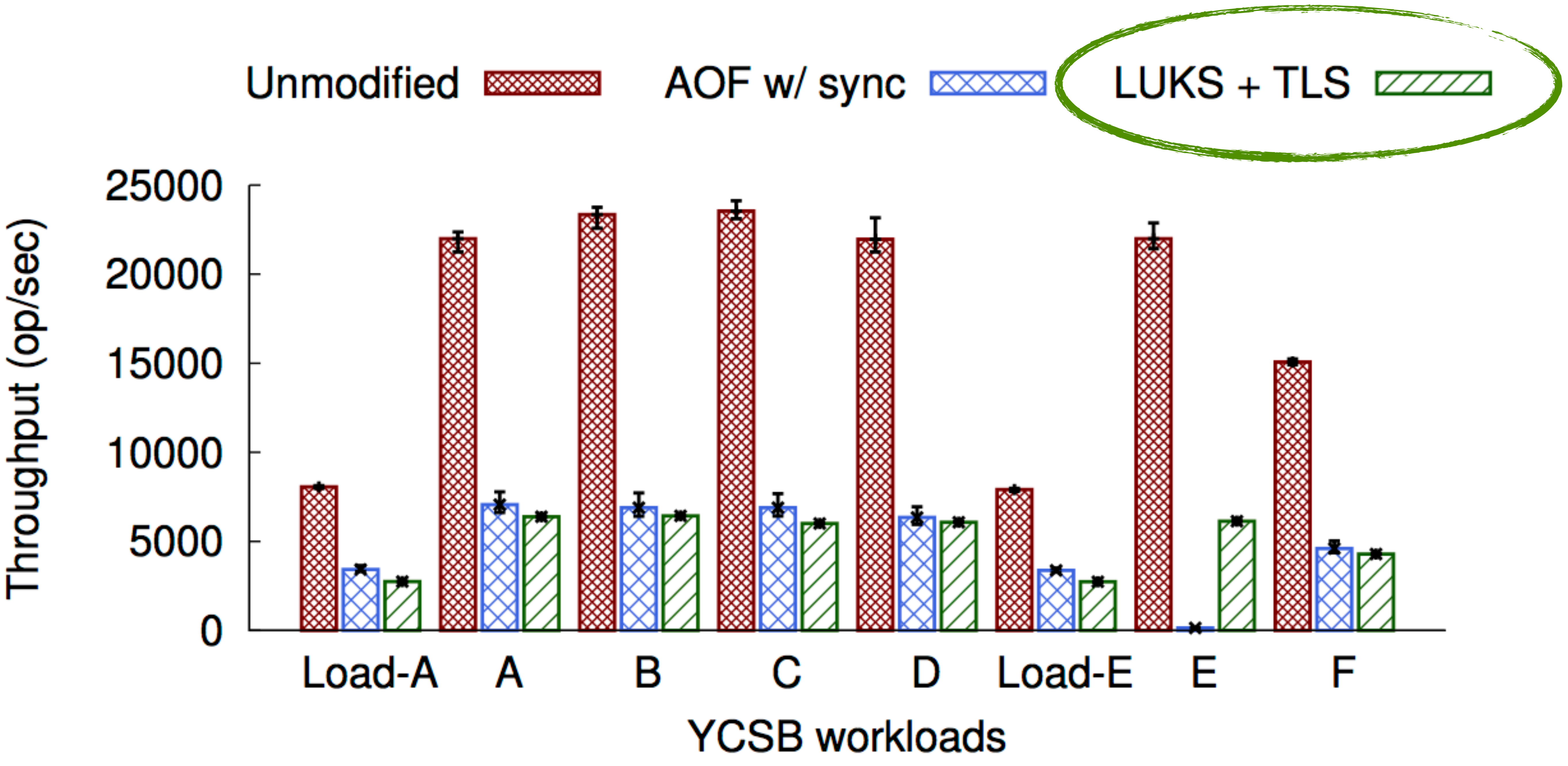
> *System internals should be carefully analyzed to determine the **degree of compliance***

GDPR-Compliant Redis: Encryption

No native support

- Encryption at rest w/ **LUKS**
- Encryption in transit w/ **STunnel**

Investigated key-level encryption using Themis (== similar performance overhead)



> *Retrofitting new features* ***not aligned*** *with the* ***core design principles*** *of the system will result in excessive performance* ***overheads***

Concluding Remarks

GDPR-compliant Redis

Performance impact of GDPR on a modern storage system

Research challenges

Efficient Logging; Efficient Deletion; Efficient Metadata indexing

Beyond GDPR

California's CCPA is going into effect 1/1/2020

We want to hear from you!

https://utsaslab.github.io/research/gdpr/