Verifiable Member and Order Queries on a List in Zero Knowledge

Esha Ghosh

Brown University

Joint work with:
Olga Ohrimenko, Microsoft Research
Roberto Tamassia, Brown University

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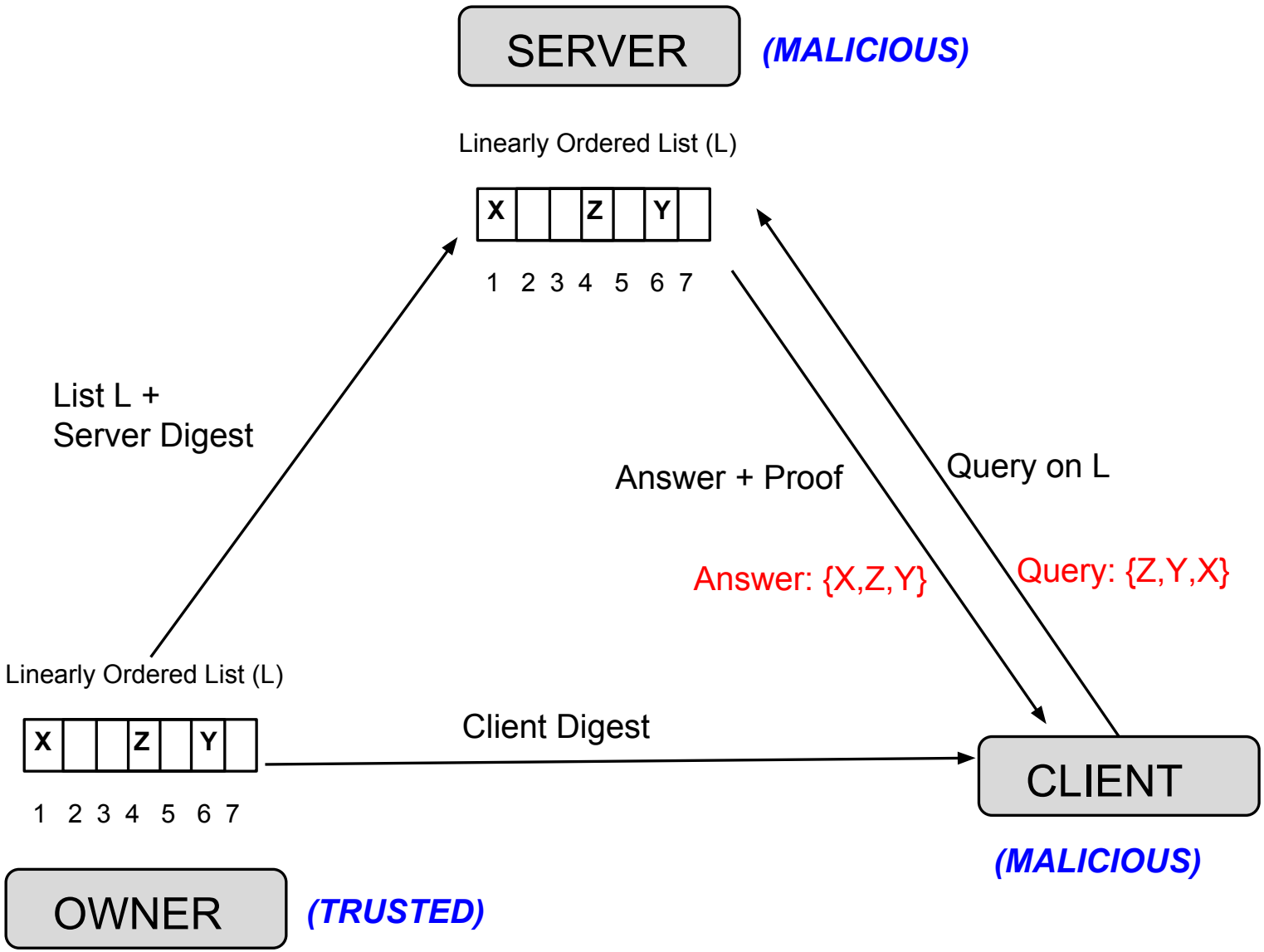
Selectively revealing health record [BB12]

Vaccine	Date given (mm/dd/yyyy)	Administered by
Hepatitis B		
Diptheria, Tetanus		
Haemophilus influenzae type b		
Polio		
Rotavirus		
Measles, Mumps and Rubella		
Varicella		
Hepatitis A		
Meningococcal		
Human papillomavirus		

Model - Privacy Preserving Authenticated List (PPAL)



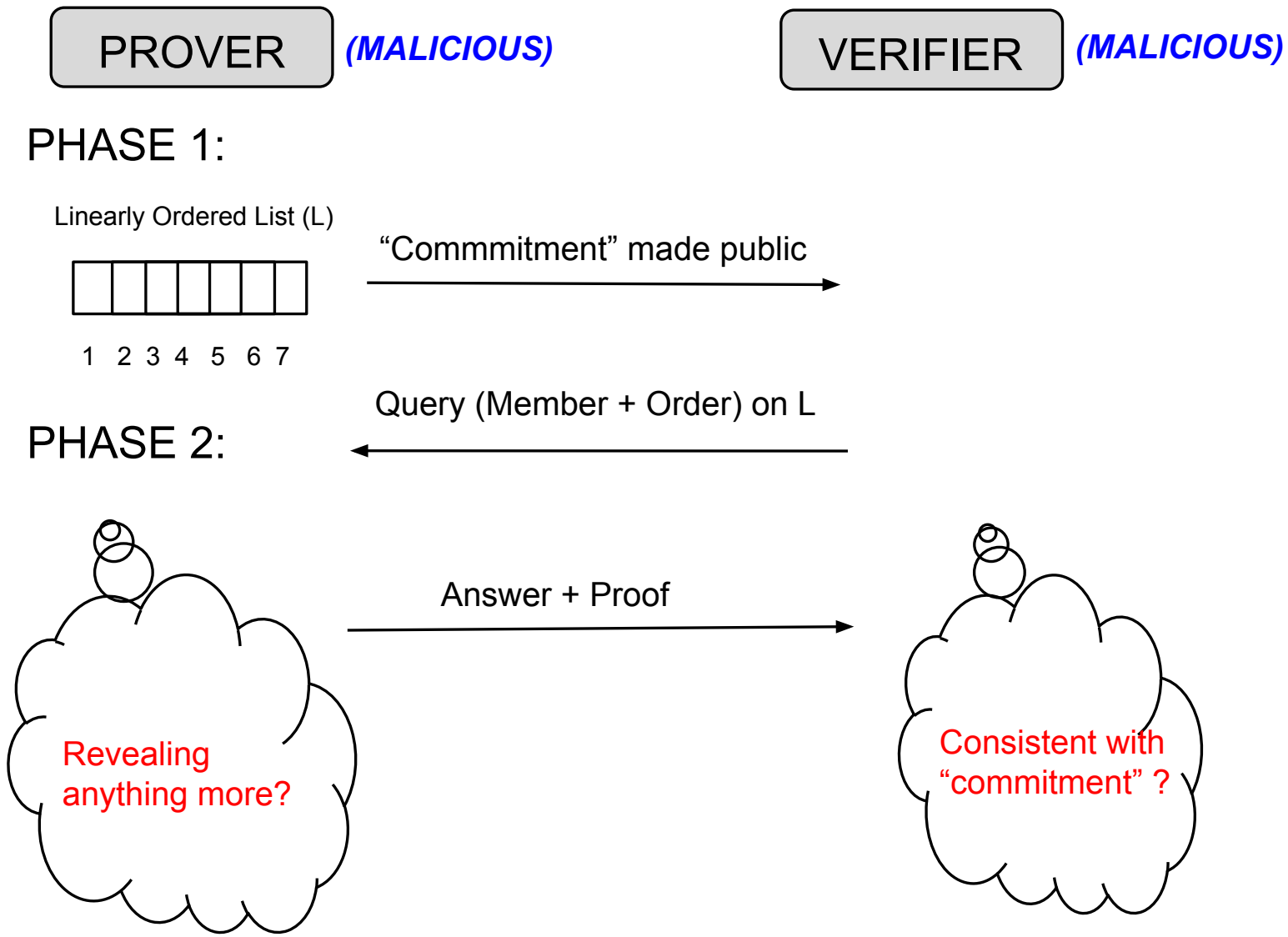
Security Properties - PPAL

Completeness: Honestly generated proofs are always accepted by the client.

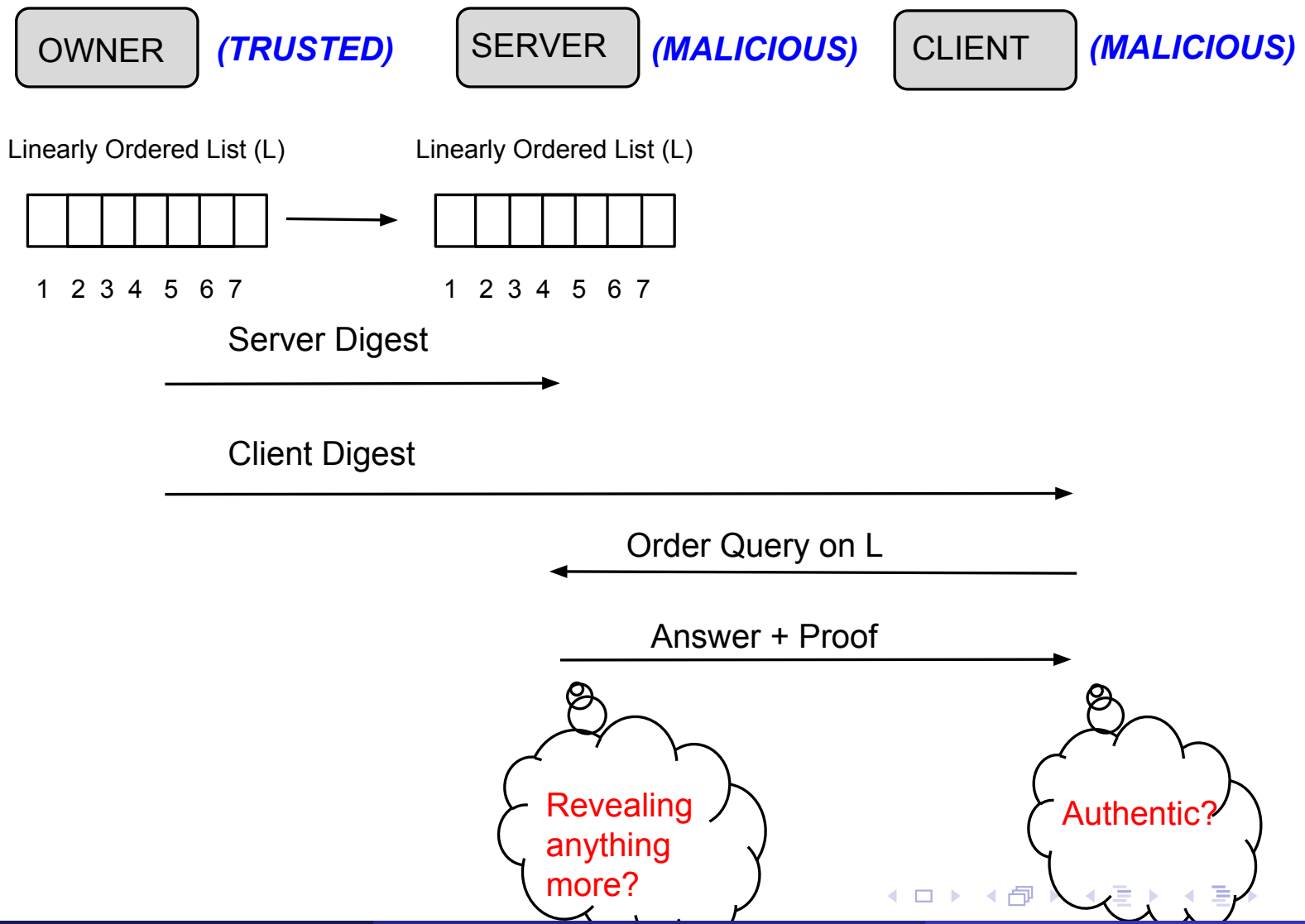
Soundness: Proofs forged by the server for incorrect answers to queries do not pass the verification.

Zero-Knowledge: Proofs do not reveal anything beyond the answers, i.e., the proofs are simulatable.

Solution 1: Zero-Knowledge List (ZKL)



Solution 2: Direct Privacy-Preserving Authenticated List (PPAL) Construction



Efficiency Comparison:

Notations:

n = List size

m = Query size

k = Security parameter

	Time Complexity		Space Complexity	
	via ZKL	PPAL	via ZKL	PPAL
Owner (Setup)	$O(kn)$	$O(n)$	$O(kn)$	$O(n)$
Server (Query)	$O(km)$	$O(min\{m \log n, n\})$[1]	$O(kn)$	$O(n)$
Client (Verify)	$O(km)$	$O(m)$	$O(km)$	$O(m)$

[1] With preprocessing time $O(n)$

How we compare

	[SBZ01]	[JMSW02]	[CLX09]	[BBD+10]	[SPB+12]	[PSPDM12]	[KAB12]	This Work
Zero-Knowledge				✓	✓	✓		✓
Setup time	$n \log n$	n	n	n^2	n^2	n	n	n
Space	n	n	n	n^2	n^2	n	n^2	n
Query time	m	$n \log n$	n	mn	m	n	n	$\min(m \log n, n)$
Verification time	$m \log n \log m$	$m \log n$	n^2	m^2	m^2	m	m	m
Proof size	m	$m \log n$	n	m^2	m^2	m	n	m
Assumption	RSA	RSA	SRSA, Division	EUCMA	ROH, nEAE	AnAHF	ROH, RSA	ROH,nBDHI

Table: Comparison of our construction of a privacy-preserving authenticated list with previous work. All the time and space complexities are asymptotic. Notation: n is the number of elements of the list, m is the number of elements in the query. Acronyms for the assumptions: Associative non-abelian hash function (AnAHF); Bilinear Diffie Hellman Inversion Assumption (BDHI) n-Bilinear Diffie Hellman Inversion Assumption and n-weak Bilinear Diffie Hellman Inversion Assumption (Decisional) (nBDHI); n-Element Aggregate Extraction Assumption (nEAE); Existential Unforgeability under Chosen Message Attack (EUCMA) of the underlying signature scheme; Random Oracle Hypothesis (ROH); Strong RSA Assumption (SRSA);

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Paper at: `http://arxiv.org/abs/1408.3843`

Thank you!