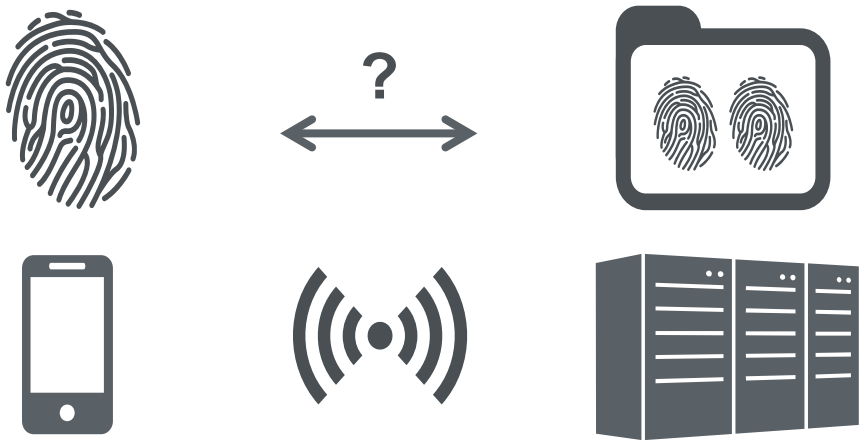
Towards Practical Two-Party Computations

Stefan Katzenbeisser

TECHNISCHE UNIVERSITÄT DARMSTADT



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DFG Deutsche Forschungsgemeinschaft

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Privacy-Enhancing Technologies (PETs)

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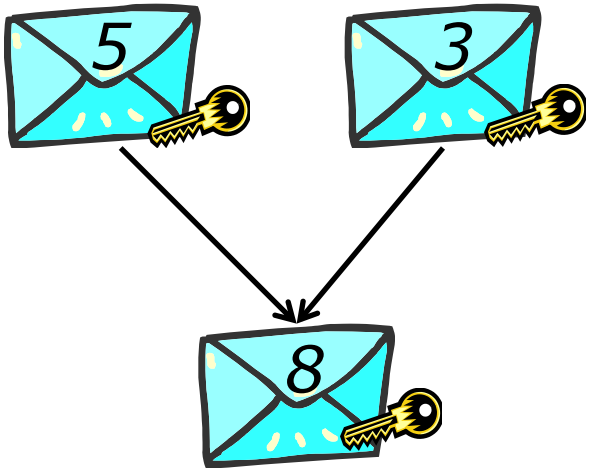
- Strike a balance between data availability and privacy
- **Paradigm:** keep data encrypted, PETs **compute with encrypted data**
- **Privacy By Design**:
  Cryptographic protocols precisely limit amount of information available
- Cryptographic tools are available!
- **S**ecure-**T**wo-party **C**omputation
  - Homomorphic encryption
  - Yao's Garbled circuits
  - Customized protocols
    (private set intersection, ...)



Applications

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Auctions

Private Set Intersection

Machine Learning

Biometric Identification

...

Secure Two-party Computation Challanges in Practice

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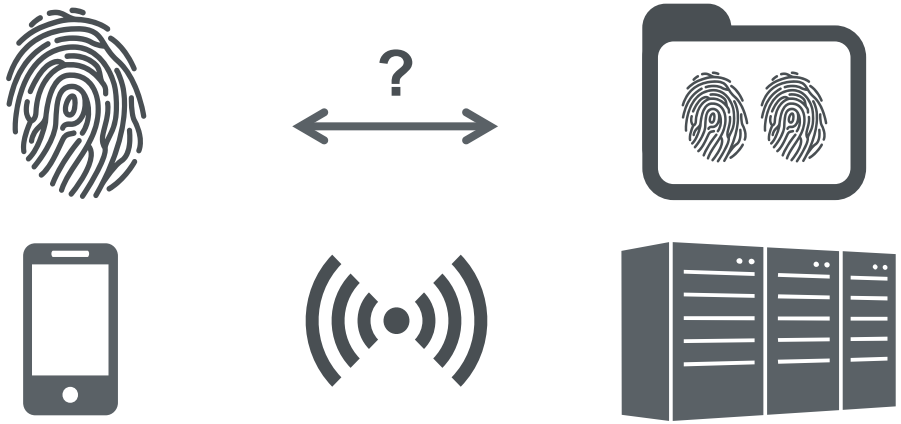
Secure computation for processing sensitive data

Complex | Resource intensive | Hard to implement

Privacy-preserving fingerprint matching between mobile and server



Selected Work @Darmstadt
Towards Practical STC

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Efficient STC Protocols & Frameworks

- More efficient **Oblivious Transfers**
- **ABY** – Framework for efficient mixed protocol STC

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Practical Compilers for STC

- **CBMC-GC** – An ANSI C Compiler for Garbled Circuits
- **ParCC** – Compiler and framework for parallel STC
- **Compiler for mixed-mode ST**

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EC SPRIDE

Efficient Oblivious Transfer

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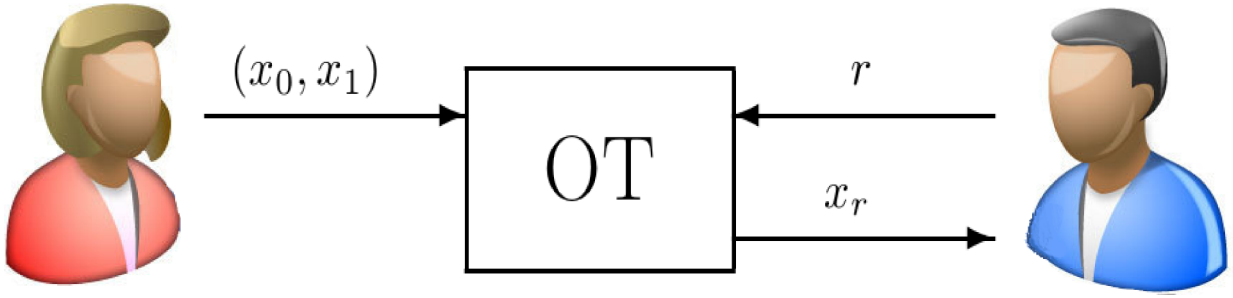
Optimizations for OTExtension in the semi-honest and malicious model

- Specific OT functionalities for more efficient STC
- Open source implementation



Asharov, Lindell, *Schneider, Zohner* (CCS'13, Eurocrypt'15)

ABY – A Framework for Efficient Mixed-Protocol Secure Two-Party Computation

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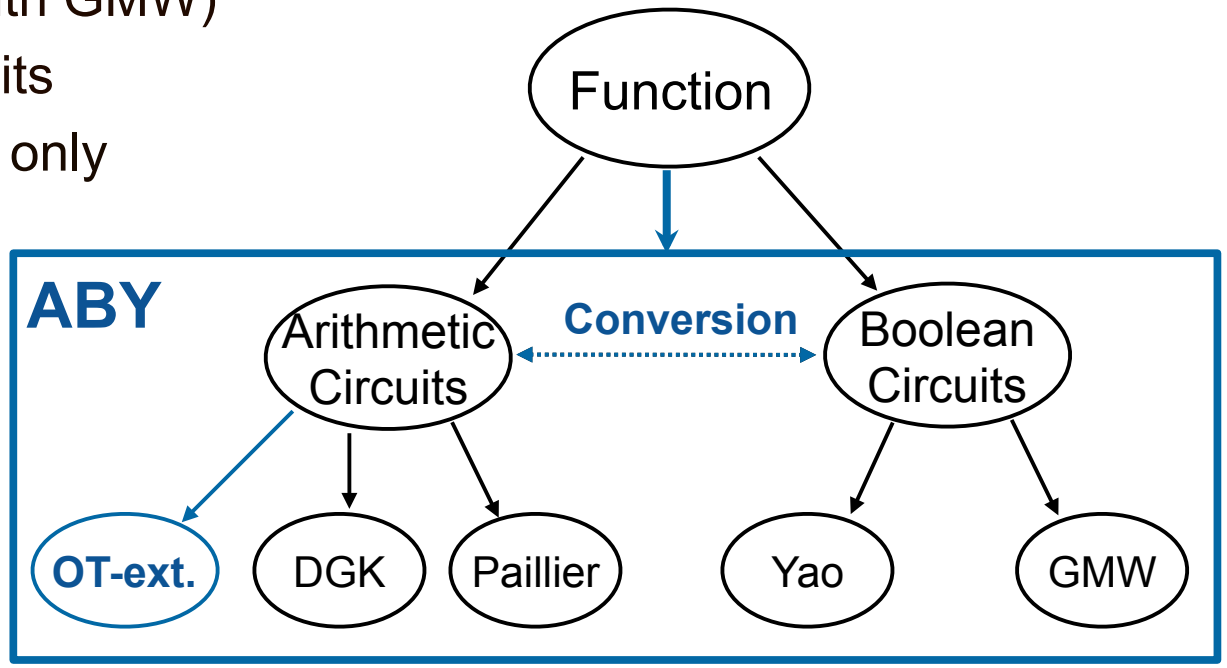
ABY: Framework for efficient mixed-protocols

- **A**rithmetic Sharing
- **B**oolean Sharing (with GMW)
- **Y**ao's Garbled Circuits

- Conversions using OT only
- Open source



Demmler, Schneider, Zohner (NDSS'15)

ABY – A Framework for Efficient Mixed-Protocol Secure Two-Party Computation

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ABY: Framework for efficient mixed-protocols

- **A**rithmetic Sharing
- **B**oolean Sharing (with GMW)
- **Y**ao's Garbled Circuits

- Conversions using OT only
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	LAN	Cloud
Yao only	2.55s	26.6s
GMW only	2.43s	39.41s
ABY	**0.19s**	**3.42s**

Example: Biometric matching with 512 samples

Demmler, Schneider, Zohner (NDSS'15)

CBMC-GC:
An ANSI-C Compiler for STC

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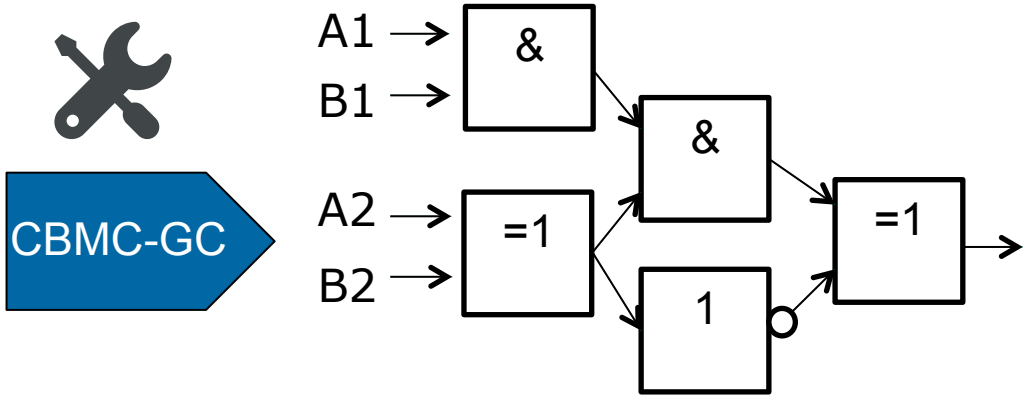
First compiler for ANSI-C to Garbled Circuits

- Supports a large subset of C, simple naming conventions
- Open source: `http://forsyte.at/software/cbmc-gc/`

```
void millionaires() {
  int INPUT_A_mila;
  int INPUT_B_milb;

  int OUTPUT_res;
  if (INPUT_A_mila > INPUT_B_milb)
    OUTPUT_res = 1;
  else
    OUTPUT_res = 0;
}
```



Holzer, *Franz, Katzenbeisser,* Veith (CCS'12, CC'14)

Extension of CMBC-GC: Automatic Parallelization

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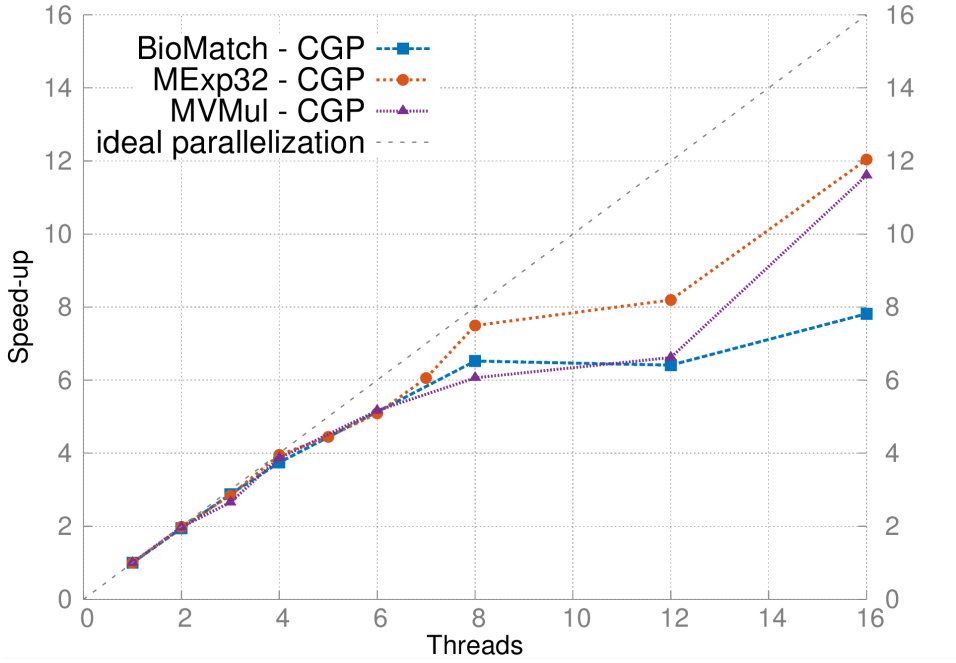
ParCC: Parallel Circuit Compiler

- Extends CBMC-GC to detect parallelism in source code
- Parallel Circuits achieve speed-ups with high efficiency even in the semi-honest model



Future Work:
Automatic, Scenario-Dependent Compiliation

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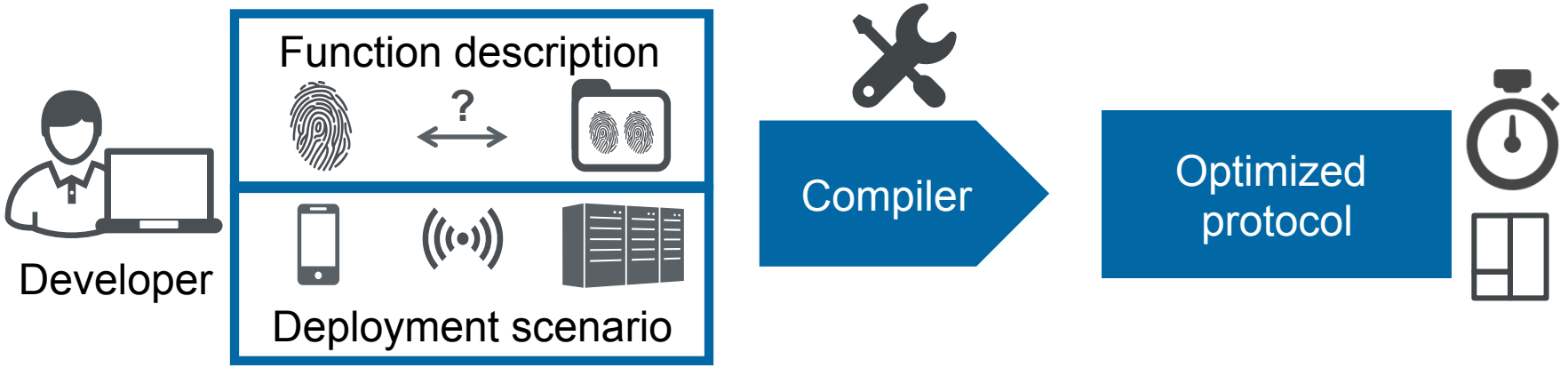
Goal Automatically generate optimized secure computation protocols.



Challenges

Metrics for efficiency comparisons

Mix multiple protocols for better efficiency

Automated generation and optimization

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