Round-Optimal Black-Box Secure Computation from Two-Round Malicious OT

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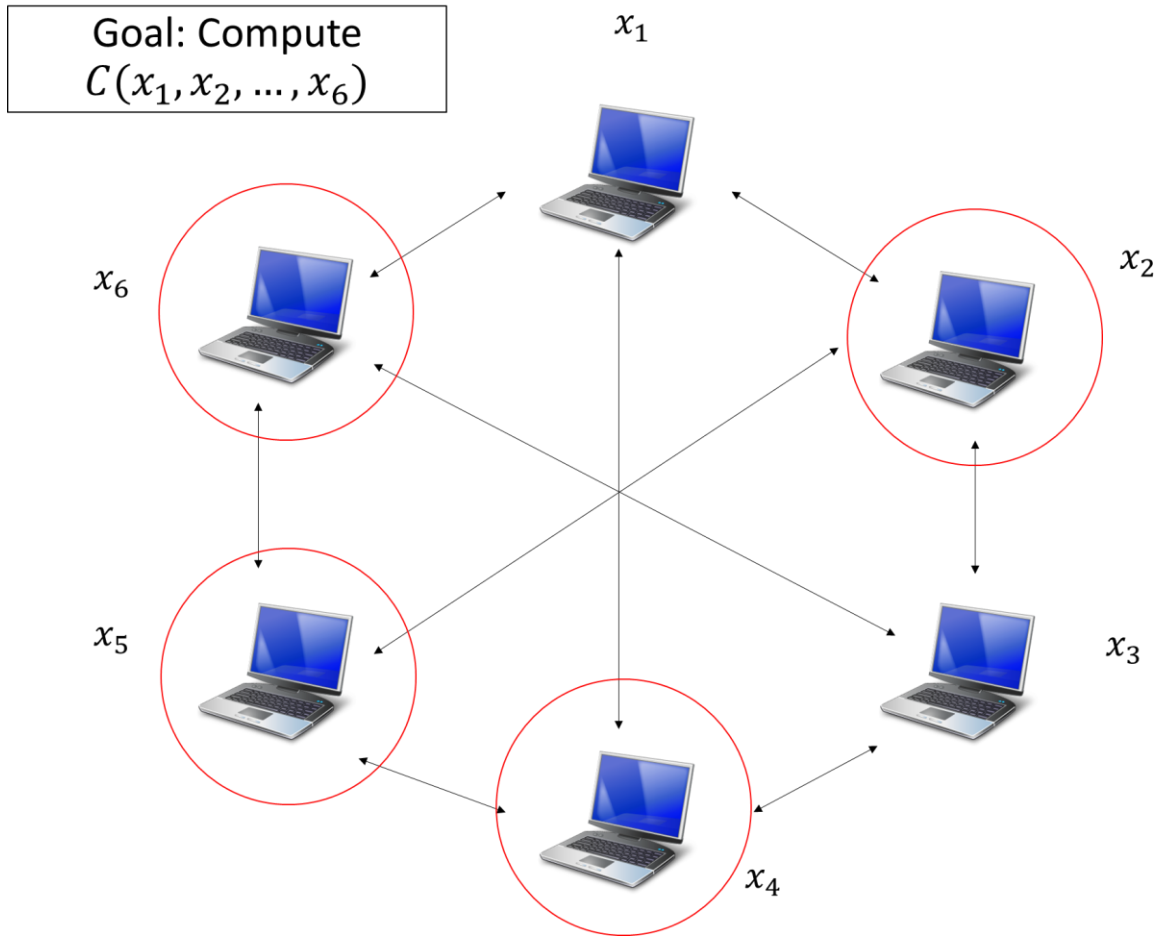
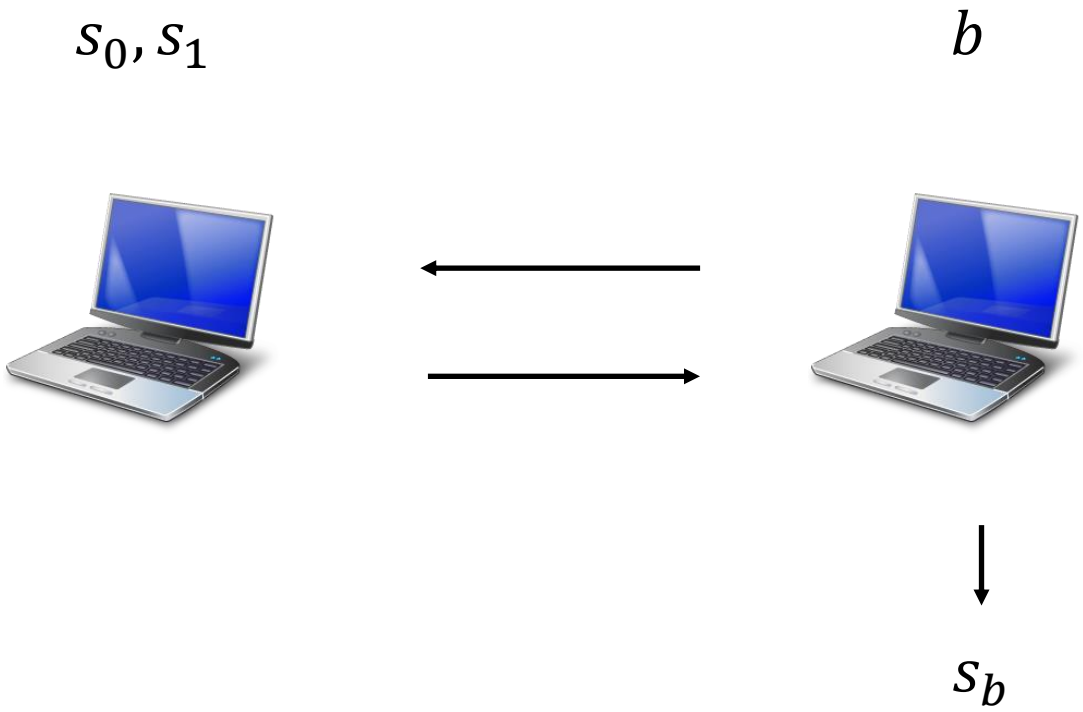
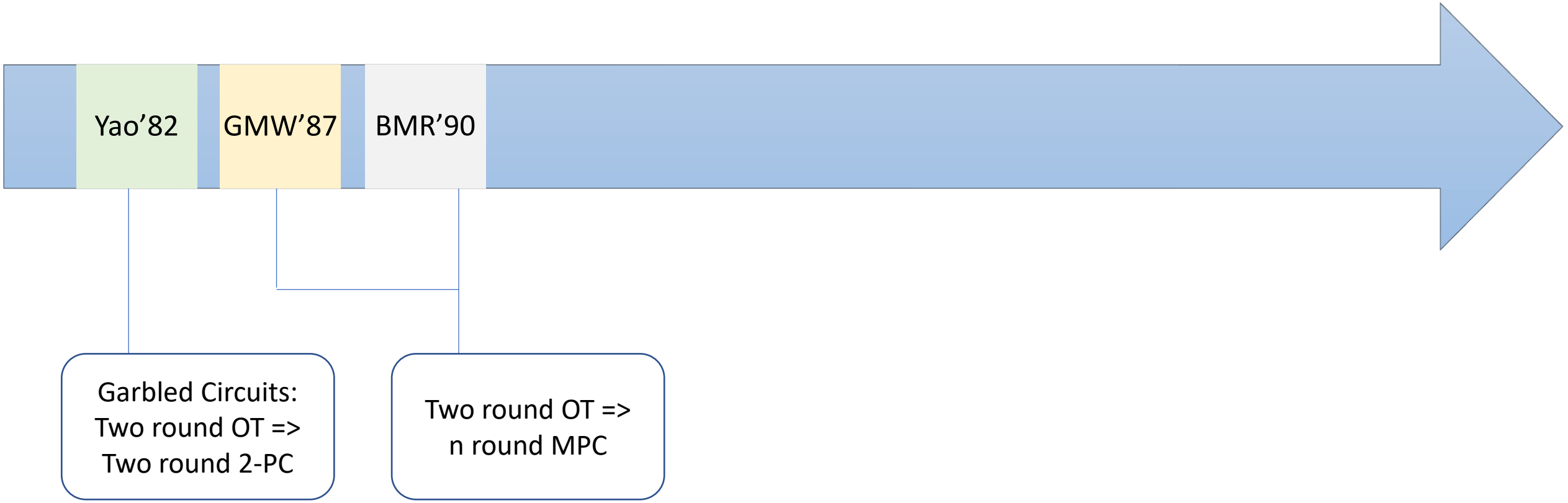
Multiparty Computation (MPC)



Building Block: Oblivious Transfer



Progress in Understanding MPC



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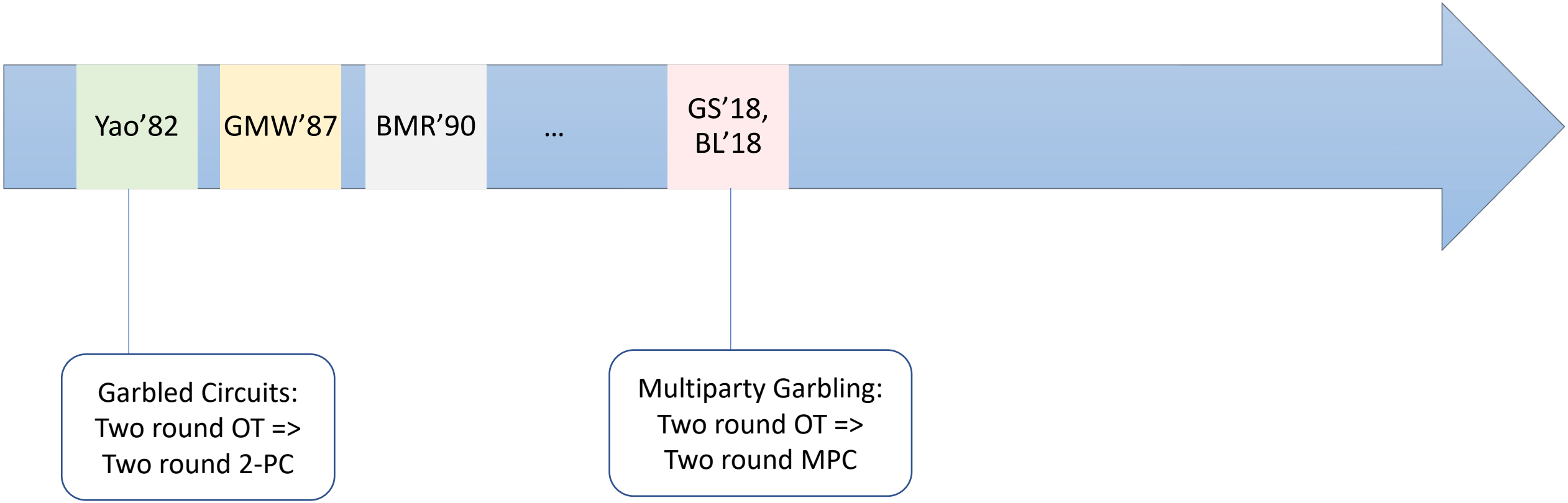
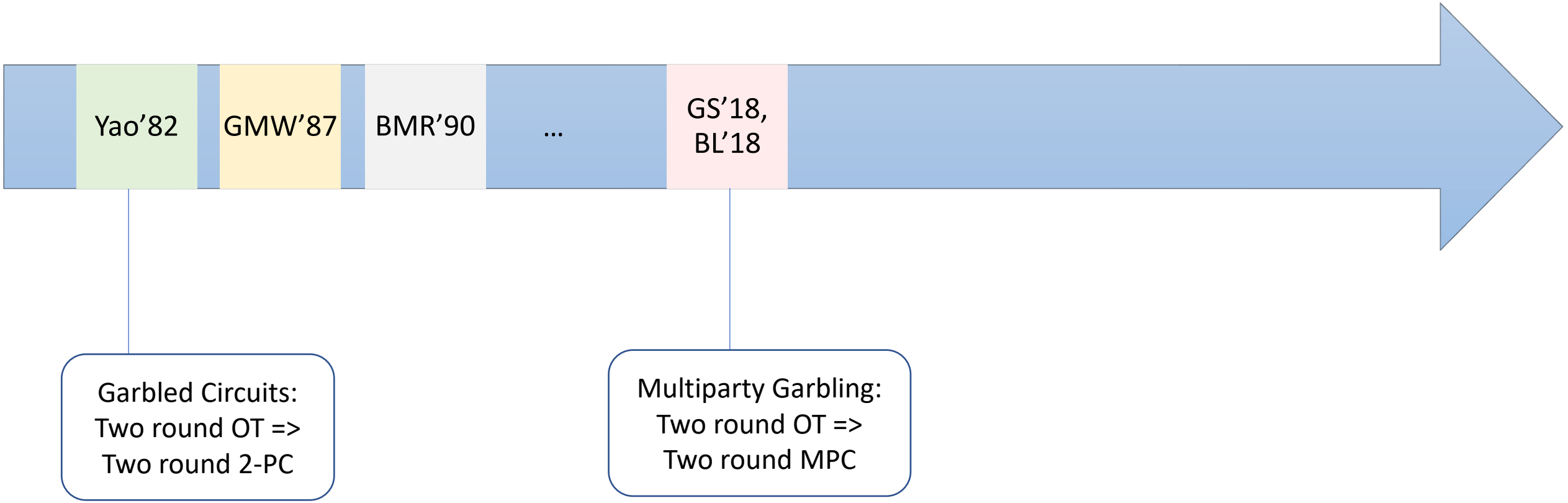


Progress in Understanding MPC

Malicious Security in the CRS Model



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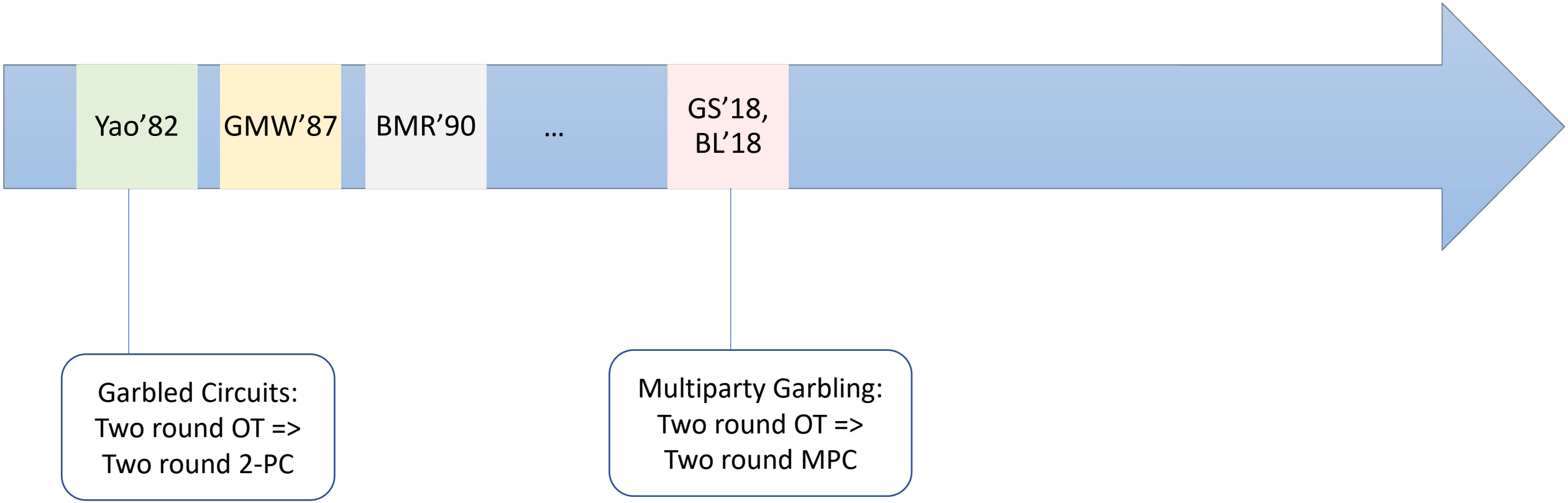

Progress in Understanding MPC

Malicious Security in the CRS Model

Garbled Circuits:
Two round OT =>
Two round 2-PC

BLACK-BOX: [IKOPS'11]

Two round *adaptive* OT =>
Three round MPC

BLACK-BOX

Progress in Understanding MPC

Malicious Security in the CRS Model

Garbled Circuits:
Two round OT =>
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BLACK-BOX: [IKOPS'11]

Two round *adaptive* OT =>
Three round MPC

Two round OT =>
Three round MPC in RO model,
Two round MPC in OT correlations model

BLACK-BOX

Progress in Understanding MPC

Malicious Security in the CRS Model

Garbled Circuits:
Two round OT =>
Two round 2-PC

BLACK-BOX: [IKOPS'11]

Two round OT =>
Three round MPC in CRS model

Matches known lower bound [ABGIS'20]

BLACK-BOX

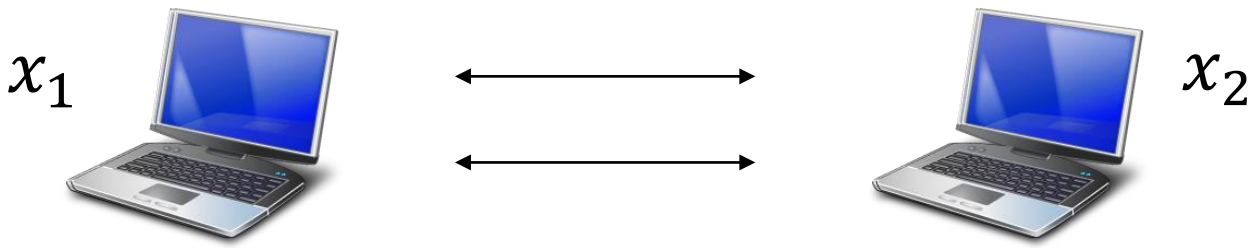
Our Results

In the common reference string (CRS) model,

- 2 round maliciously secure OT ➔ 3 round maliciously secure MPC

- 2 round maliciously secure OT ➔ 2 round 2-sided NISC

Two-Sided Non-Interactive Secure Computation (NISC)



$f(x_1, x_2)$ $f(x_1, x_2)$

Known result: Two-round One-sided NISC from black-box use of two-round OT [IKOPS'11]

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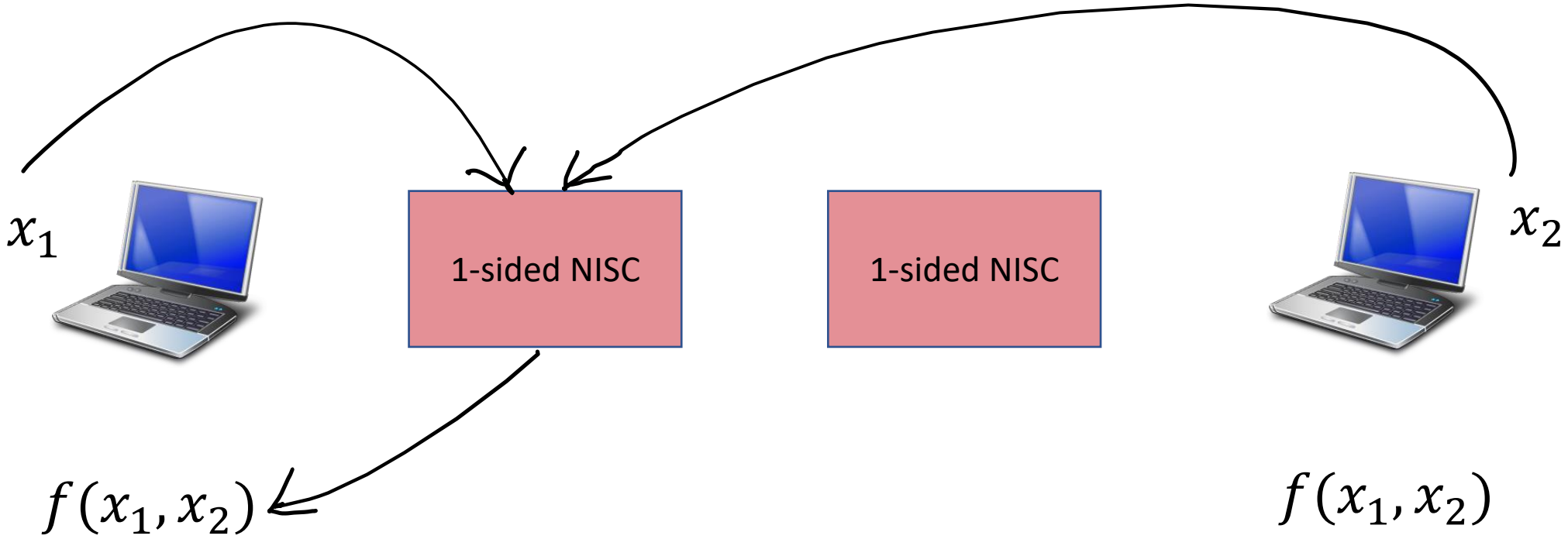

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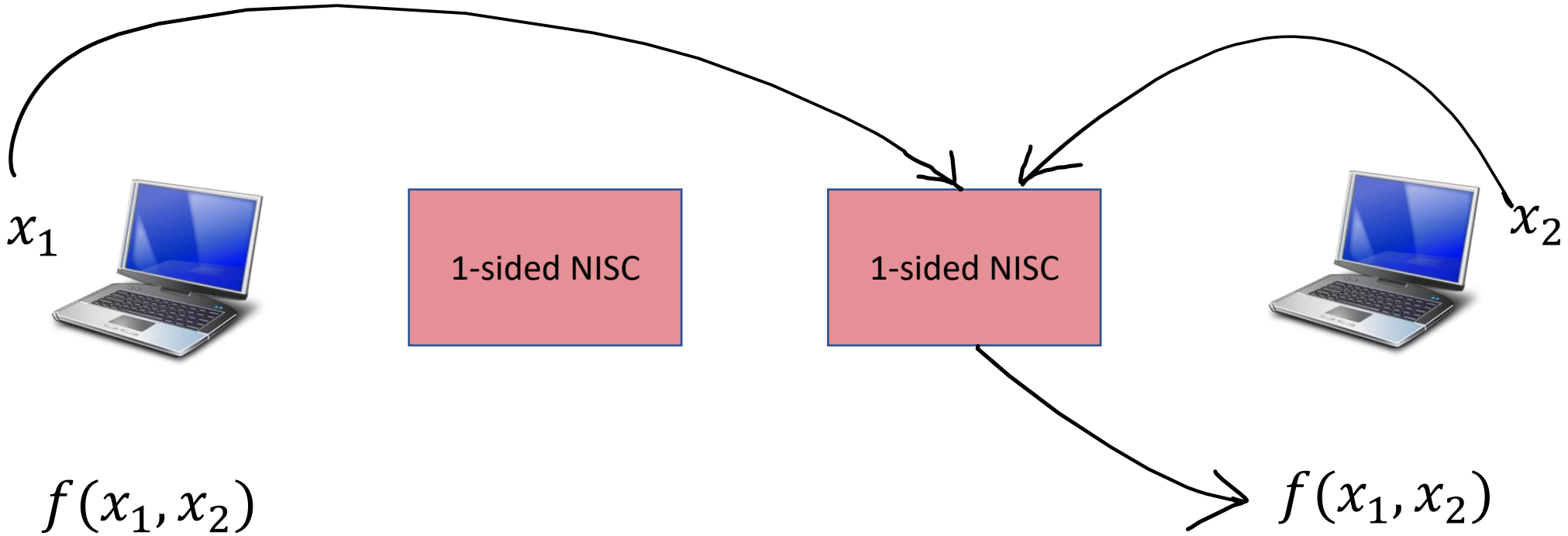

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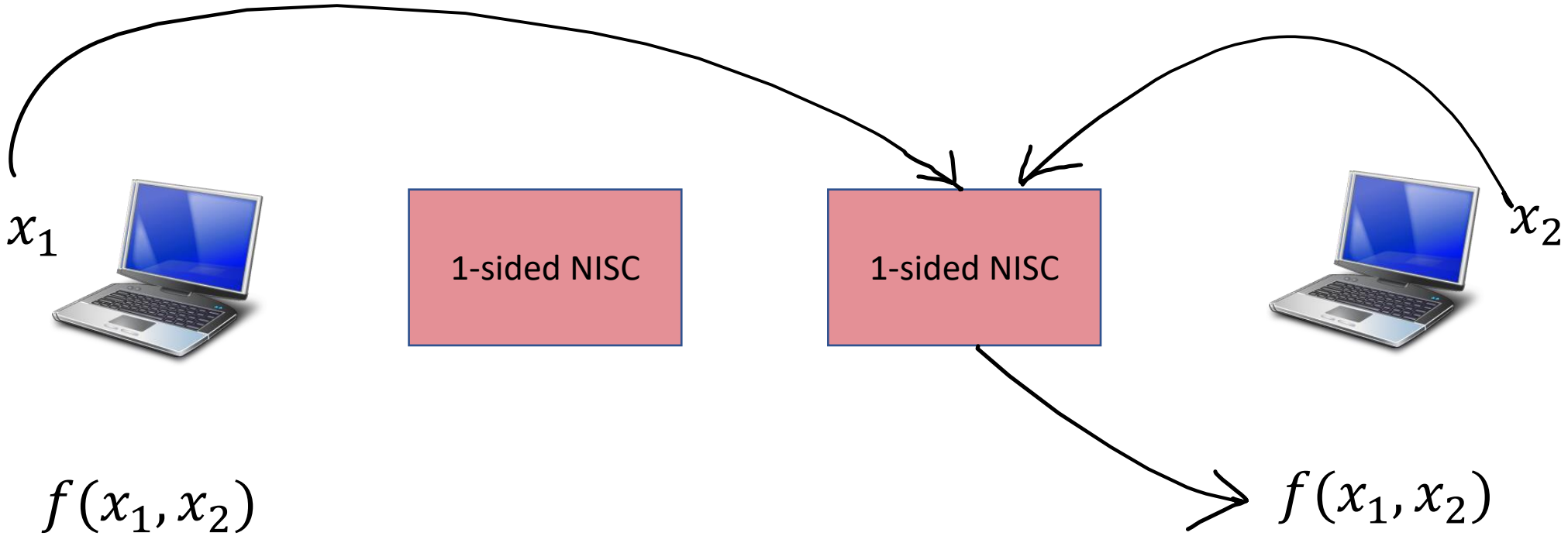
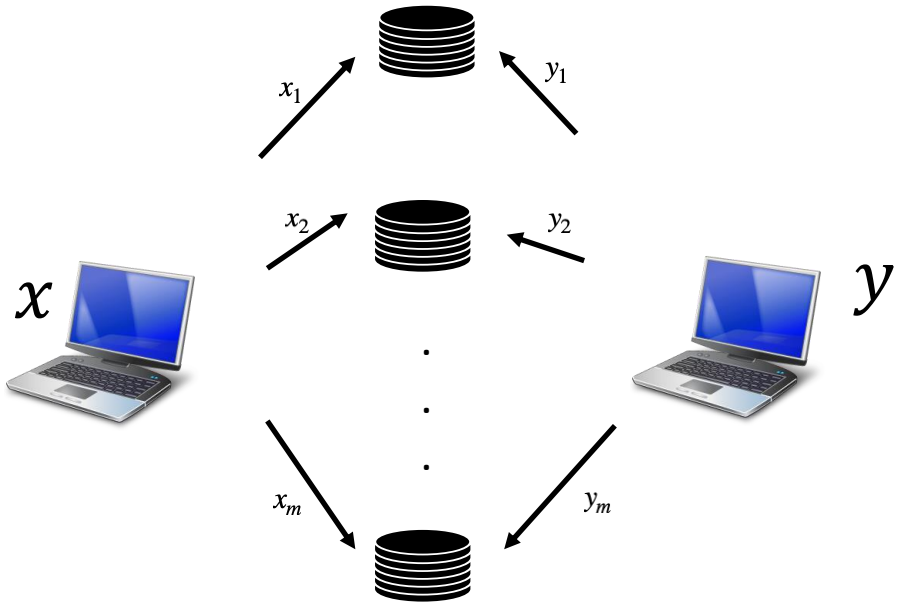


Key Technical Challenge: Ensure input consistency across executions

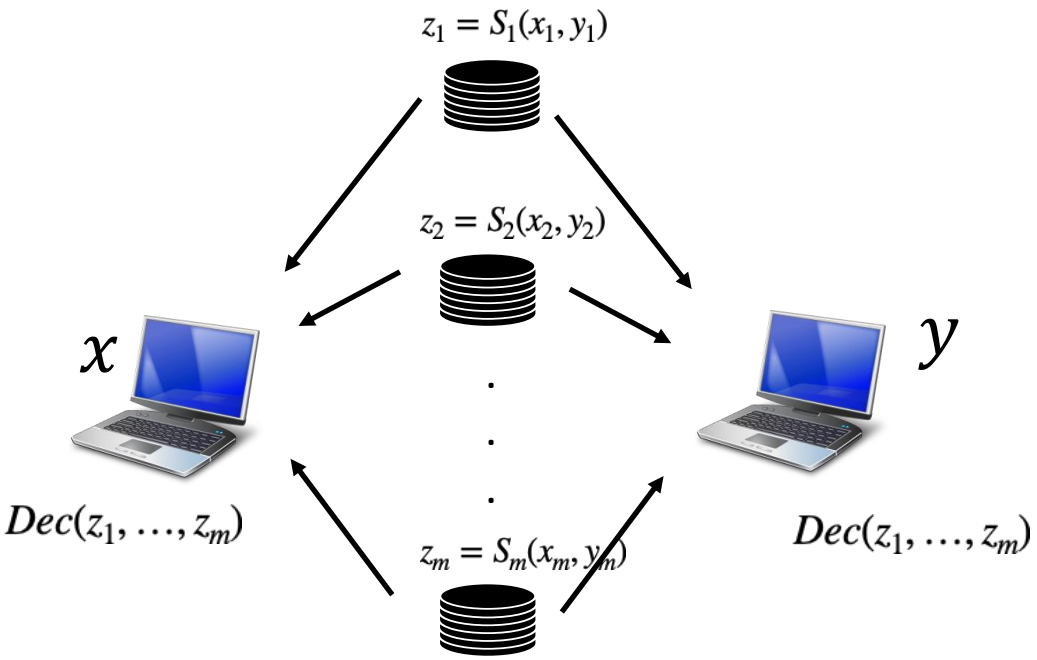
Use MPC-in-the-head techniques [IPS'08] to check input consistency

Quick Recap of the IPS Compiler



Outer Protocol

Quick Recap of the IPS Compiler



Outer Protocol

Malicious security against corruption of one of the clients and a constant fraction of servers [IKP 10].

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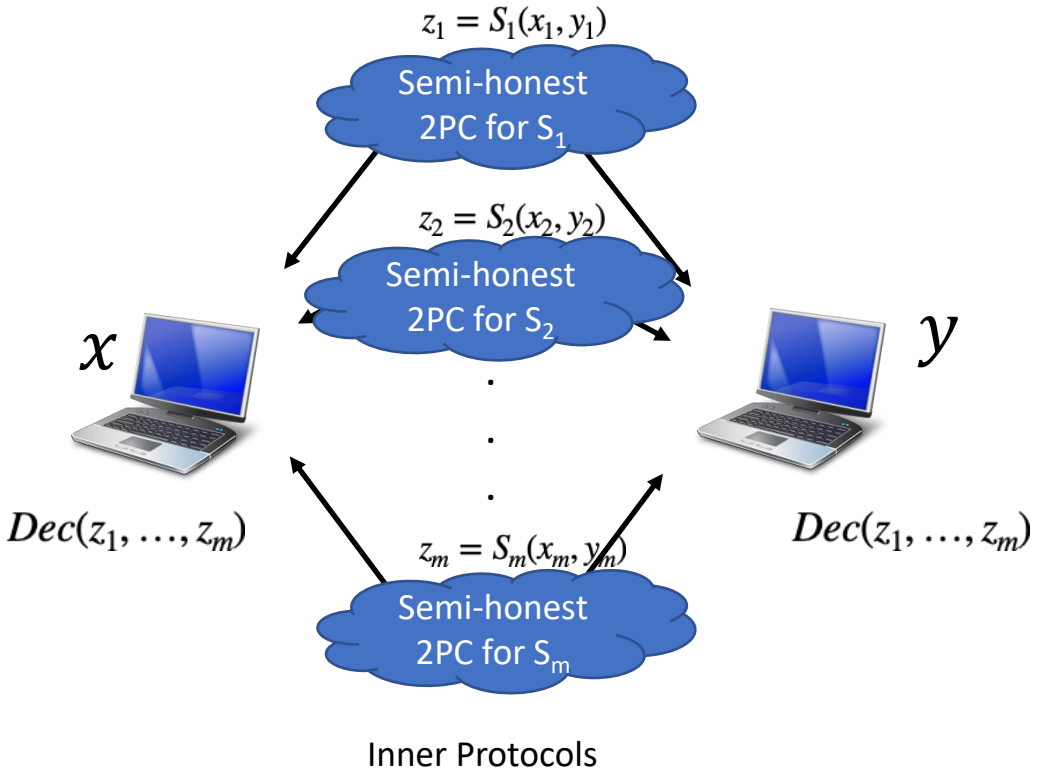

Inner Protocols

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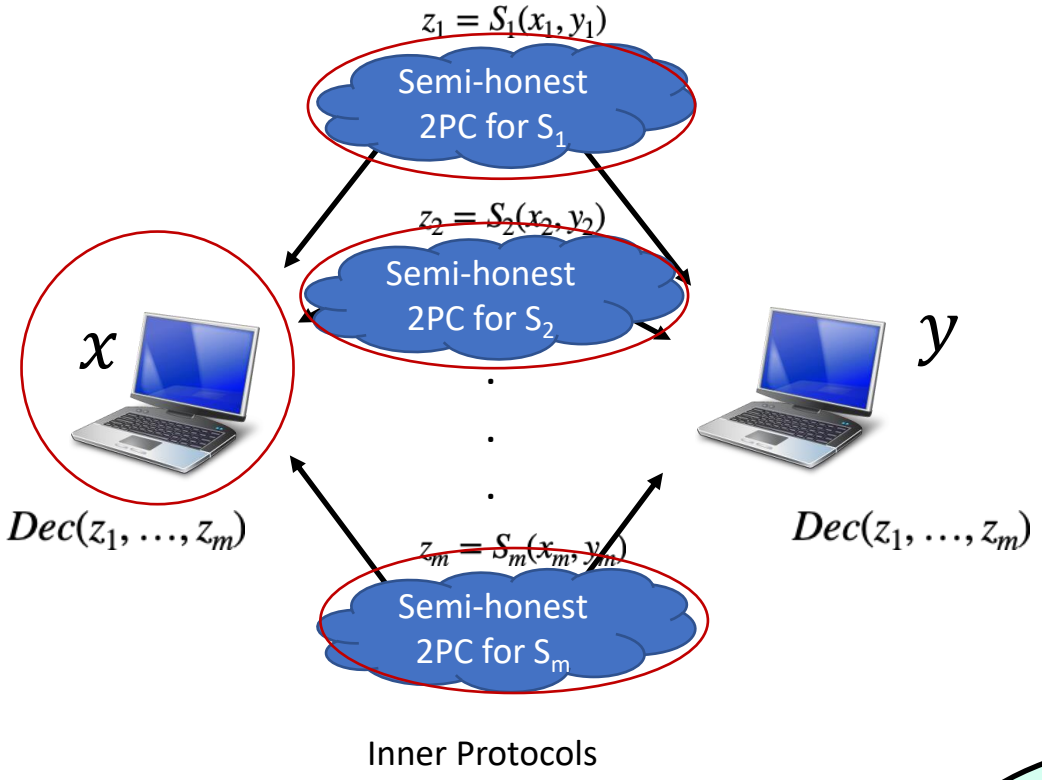

Inner Protocols

Need to ensure that adversary only cheats in a constant fraction

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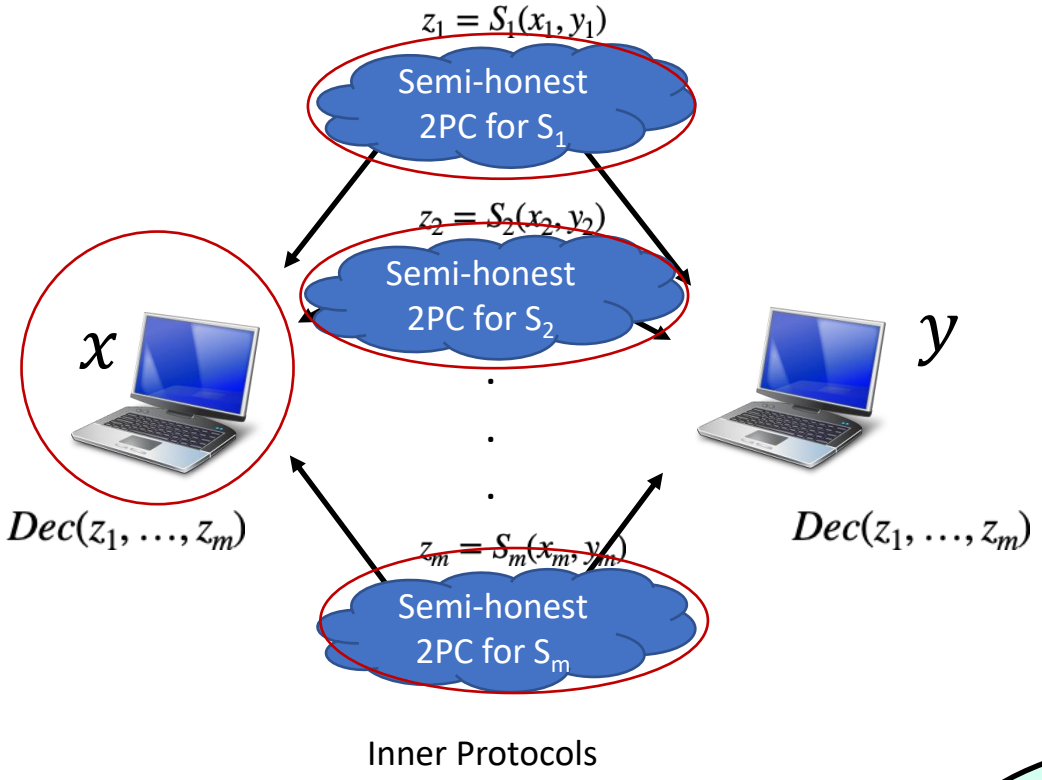

Inner Protocols

WATCHLISTS:
Cut-and-choose checks on a random subset of inner protocols

Need to ensure that adversary only cheats in a constant fraction

Specific choice of inner protocol and watchlists

- Inner Protocol should satisfy an additional output equivocality property
  - Two-sided NISC: Any one-sided NISC (which can be based on OT [IKOPS'11])
    Alternatively Garbled circuits + OT
  - MPC: Robust MPC building on [PS'21]

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- Watchlist mechanism should allow the simulator to decide and program which executions will be watched by malicious parties
  - Build this using ideas from [IKOPS'11]

Another Perspective

- Start with simple round-optimal realizations that BB use *semi-honest OT*

  semi-honest 2-sided NISC (Garbled circuits + OT)

  semi-honest MPC [PS'21]

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- Start with simple round-optimal realizations that BB use *semi-honest OT*
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  semi-honest MPC [PS'21]

- Plug in maliciously secure OT

- The result is an inner protocol, which is bootstrapped to full malicious security via the IPS compiler

Open Questions

- Obtain our results from BB use of two-round *semi-honest* OT
- Base 3 round MPC on *3 round* maliciously secure OT
- Can similar results be obtained in the *OT-hybrid model*?