Computing with Liquid Computing:
Challenges and Promises

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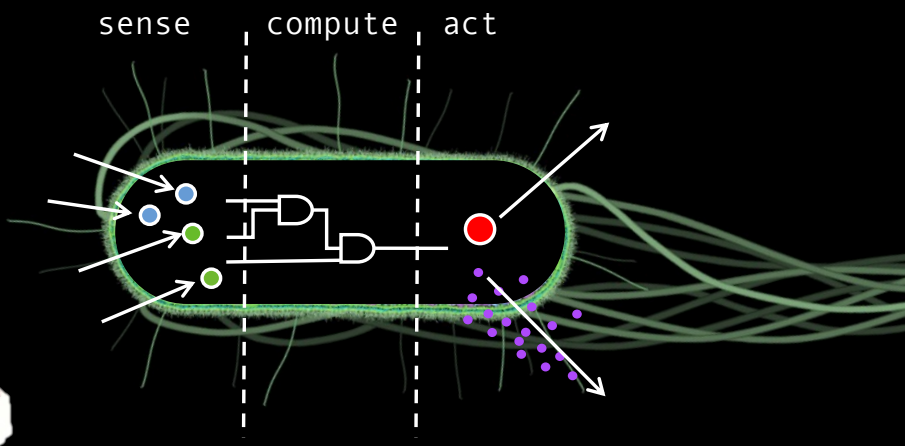
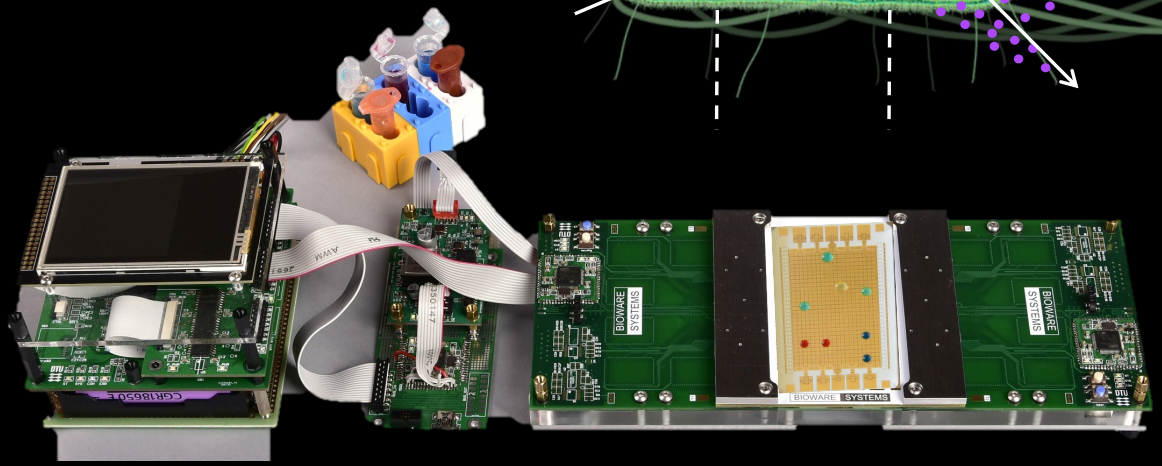
MPSoC 26, Victoria, BC, Canada, 22-6-2026

Previously

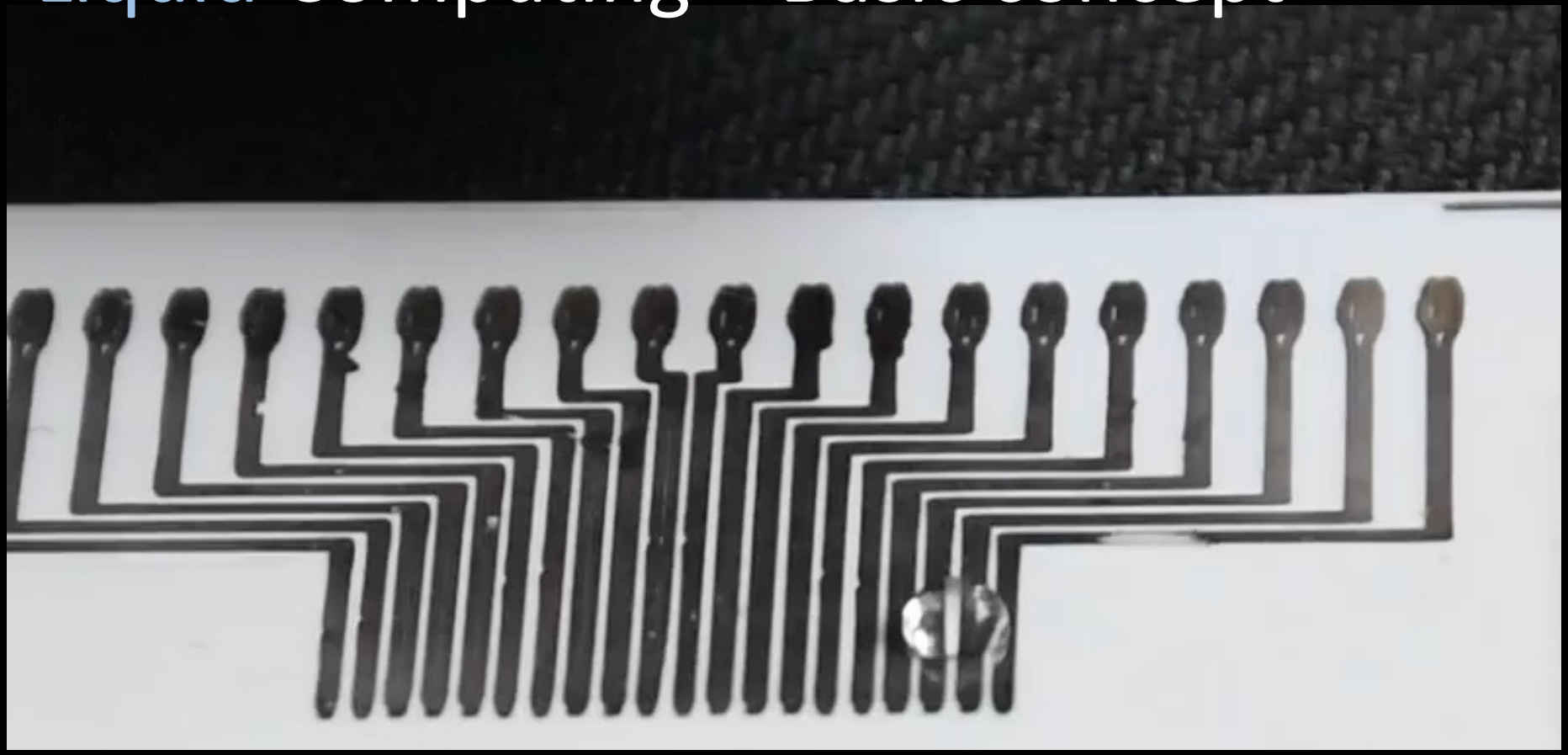
- MPSoC 2022
  Computing with Biological Circuits

- MPSoC 2024
  Liquid Computing

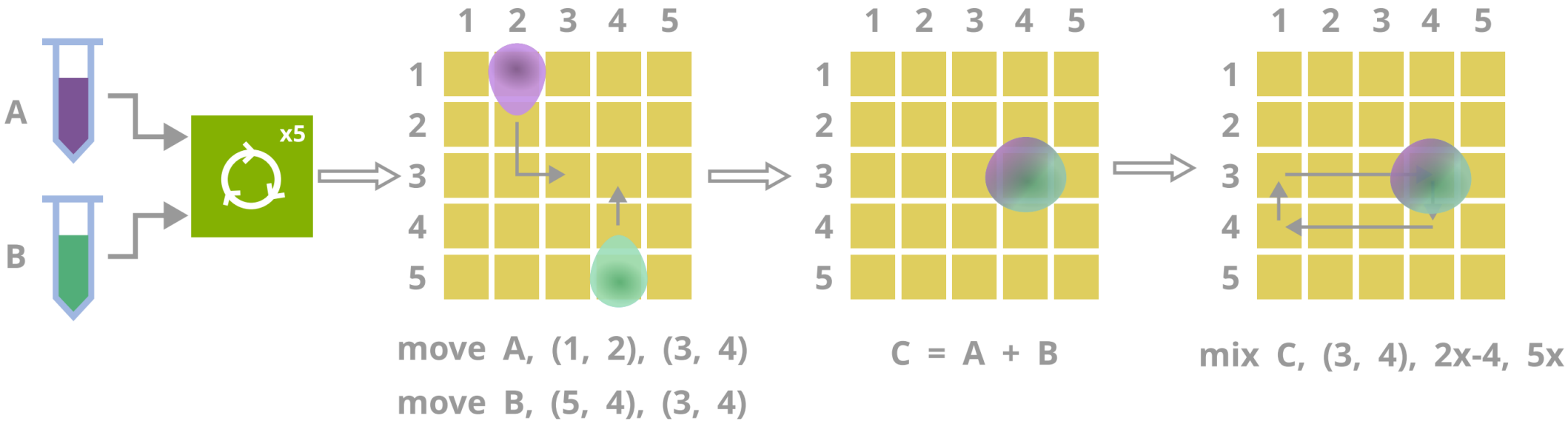




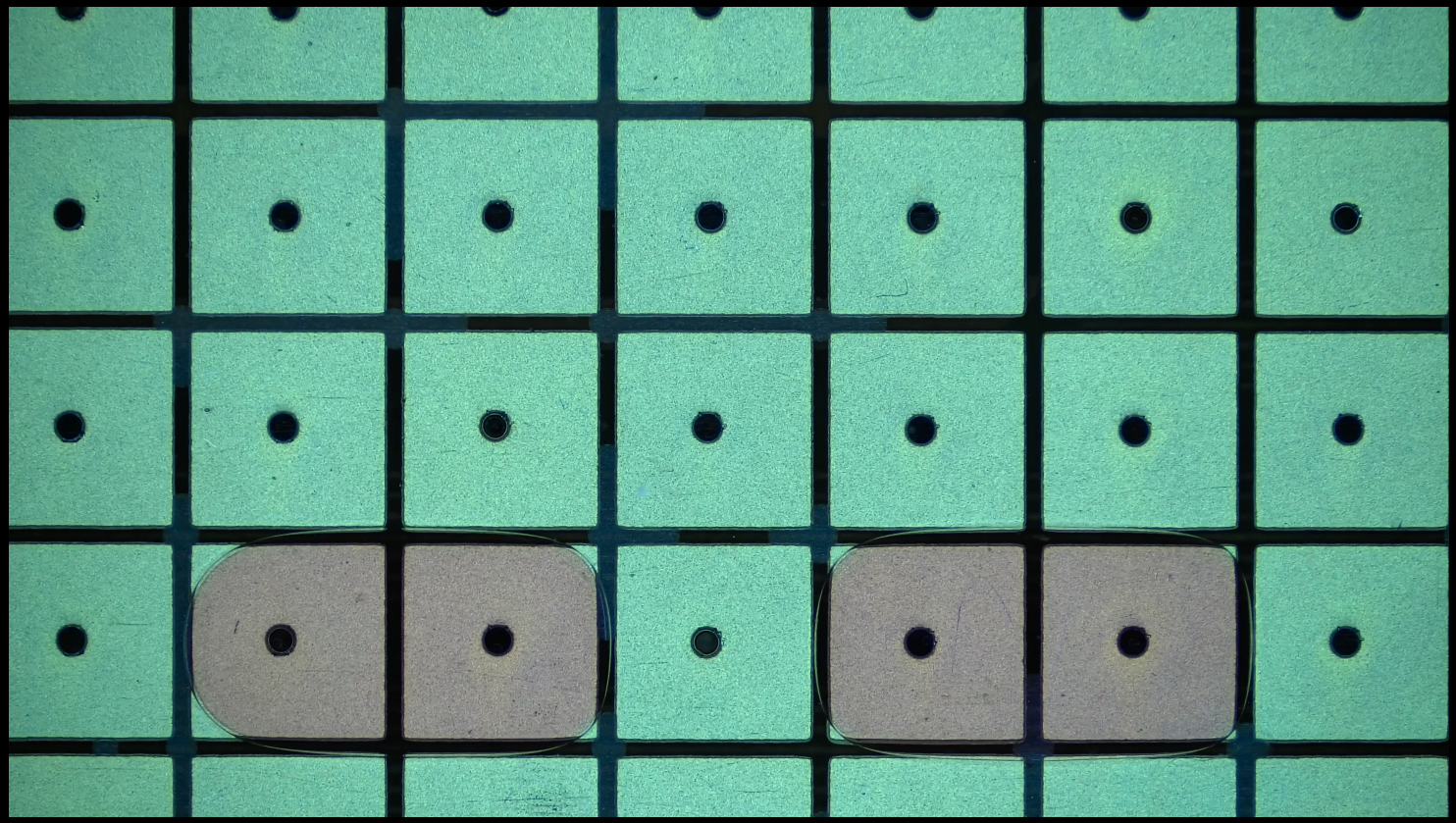
Liquid Computing – Basic concept



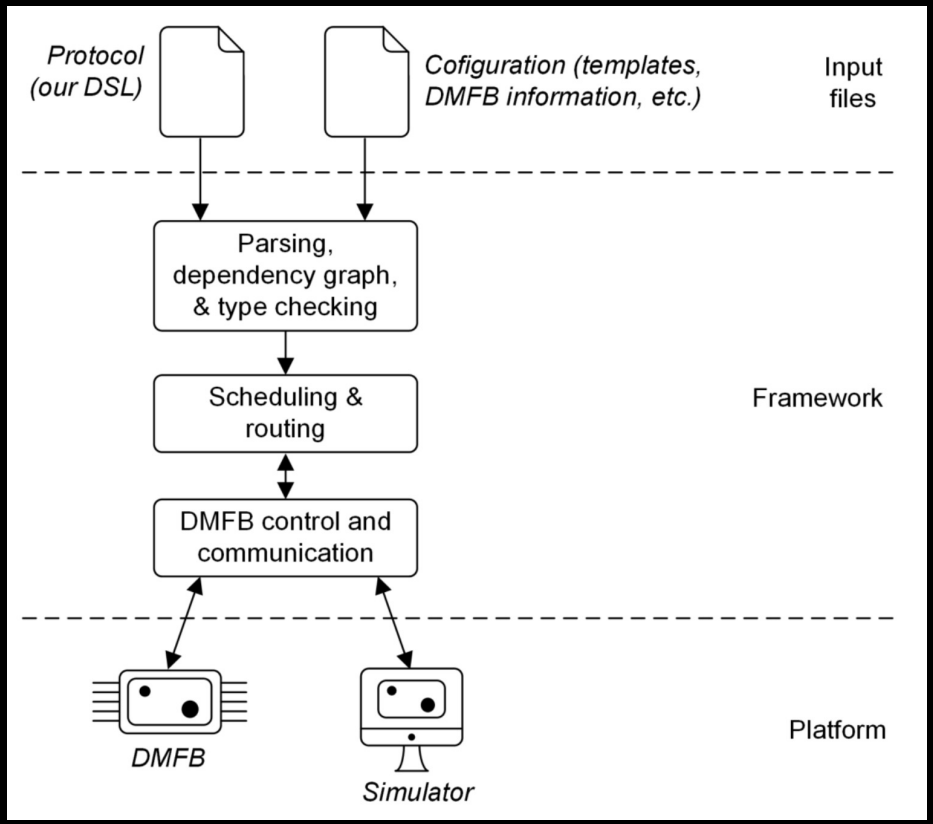
Liquid Computing – Programming concepts



Liquid Computing – Advanced operations



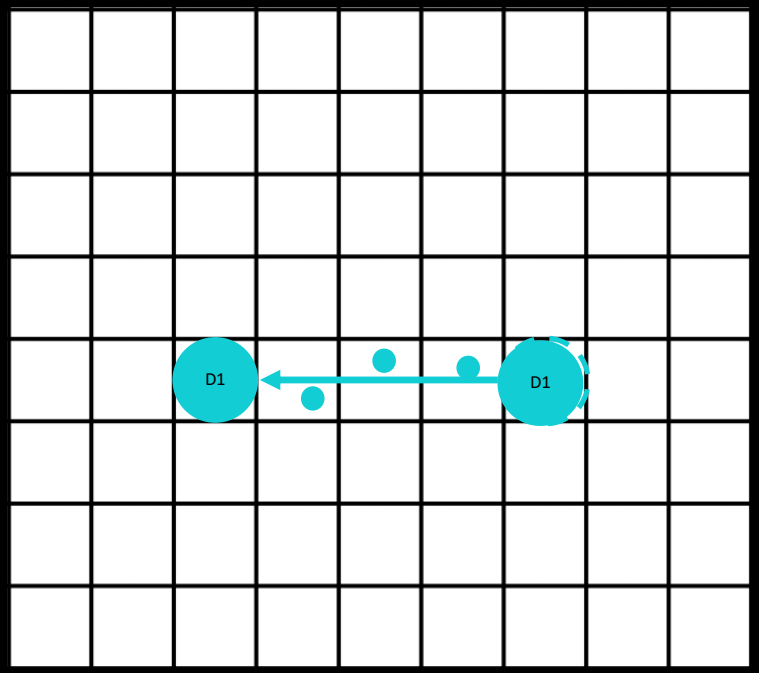
Liquid Computing: Tool chain



- JIT compiler -> dynamic control
- Real-time monitoring and decision making based on real-time inputs
- Each droplet is an agent within a multi-agent pathfinding problem
- Reaching target avoiding unintended collisions and contermination zones

Liquid Computing Challenges

Droplet contamination



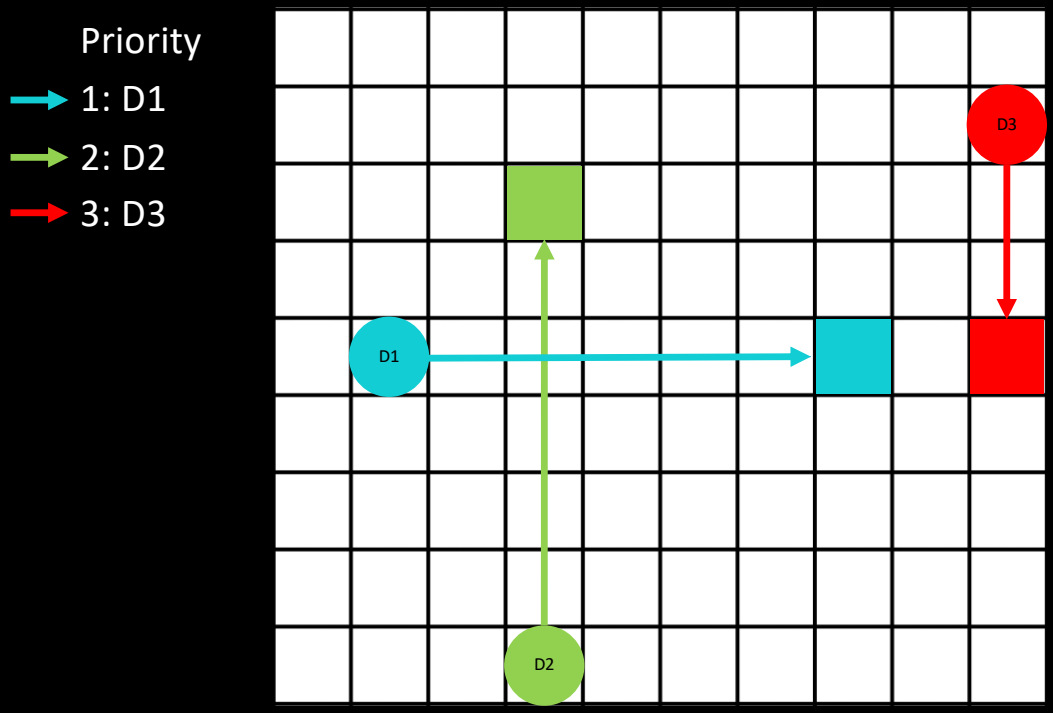
Contamination Table

	Water	Blood
Water	F	T
Blood	F	F

Blood contaminates Water

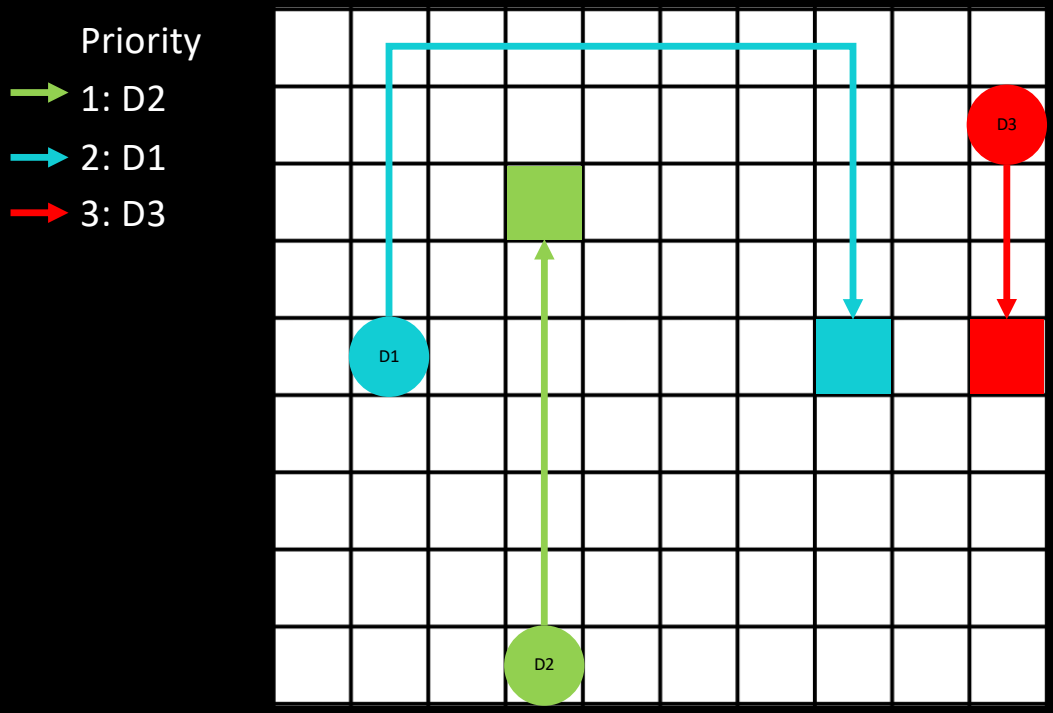
[MSc project by Joel Madsen and Alexander Collignon, 2025]

Droplet contamination



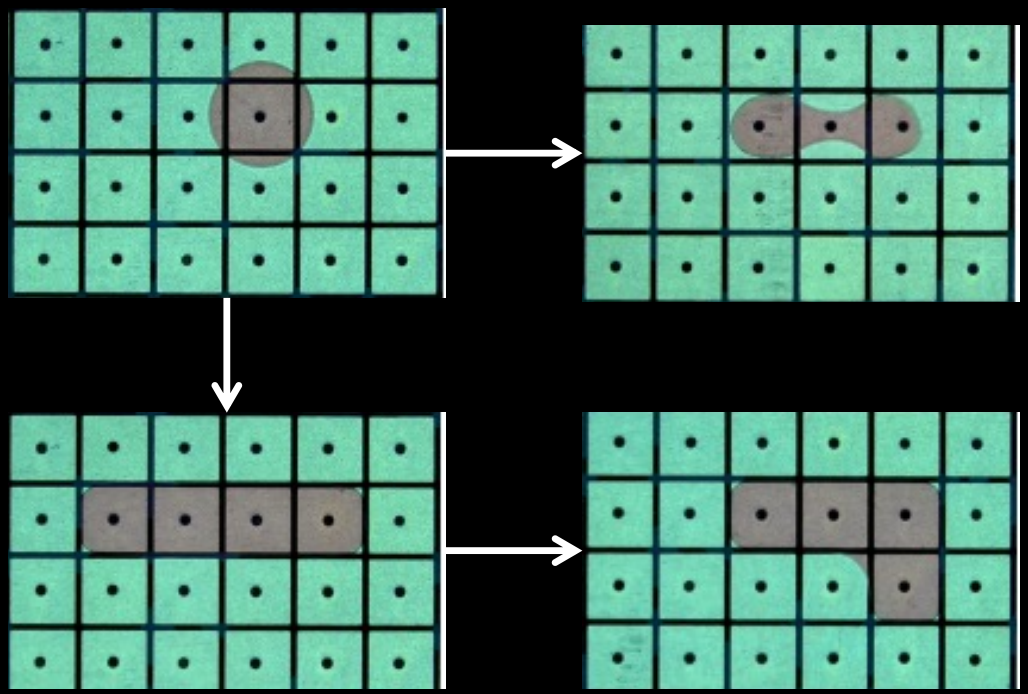
[MSc project by Joel Madsen and Alexander Collignon, 2025]

Droplet contamination

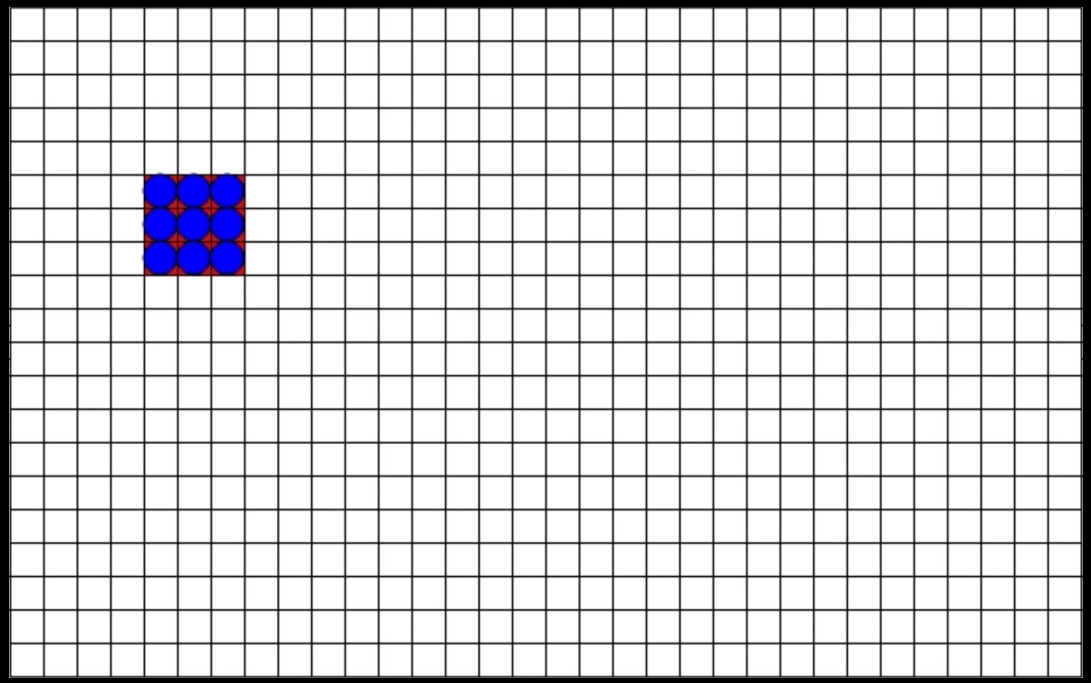


[MSc project by Joel Madsen and Alexander Collignon, 2025]

Droplet shaping



Large droplets

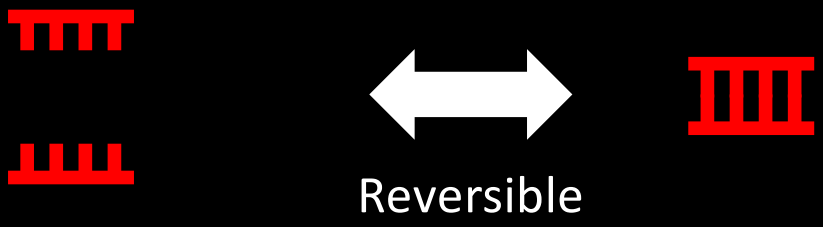


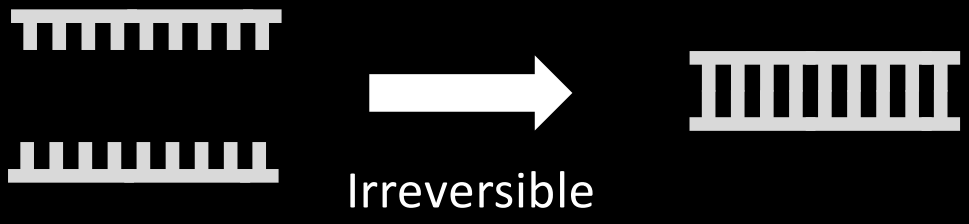
[MSc project by Joel Madsen and Alexander Collignon, 2025]

Liquid Computing Promises

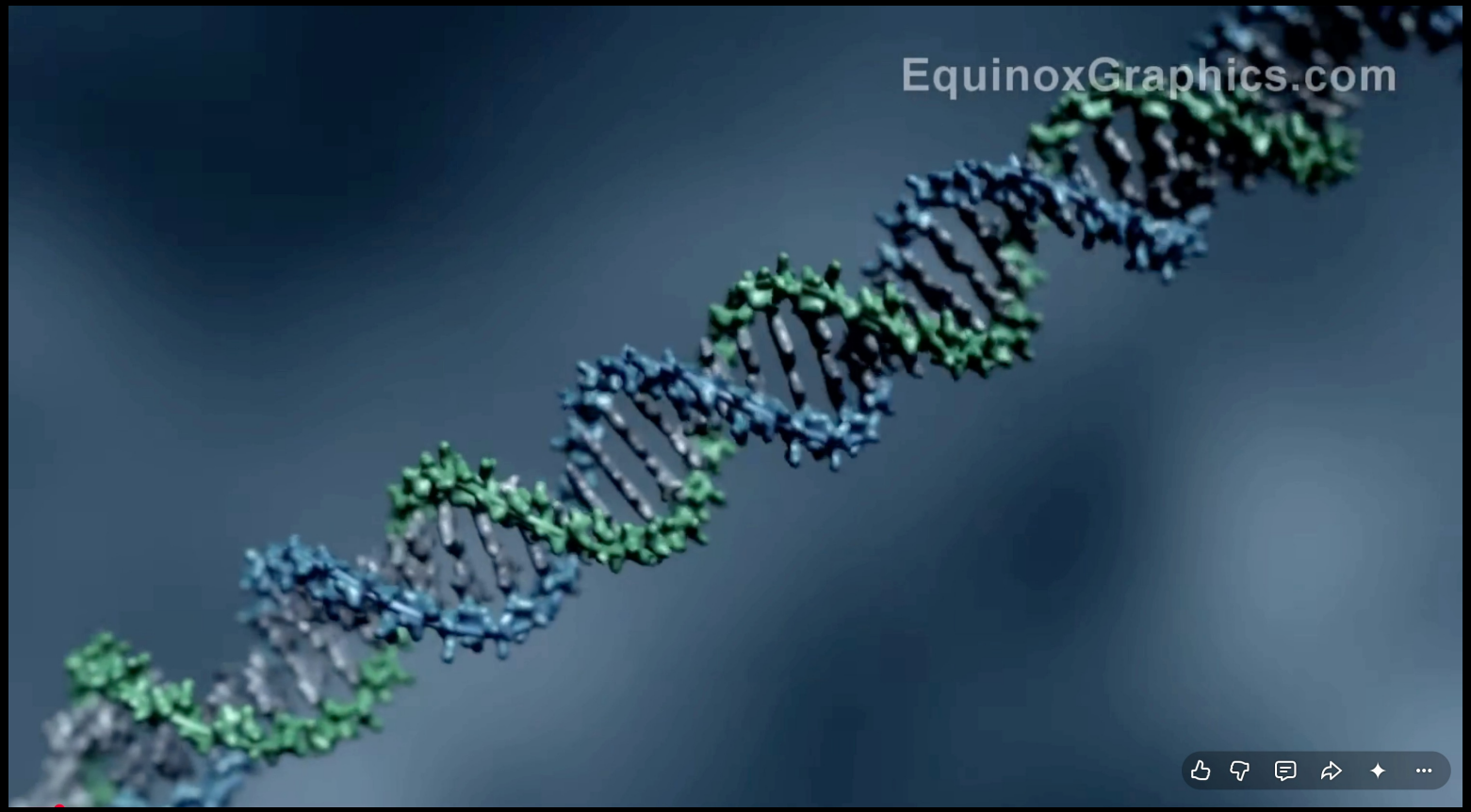
DNA Strand Displacement

Basic properties





Toehold-Mediated Strand Displacement



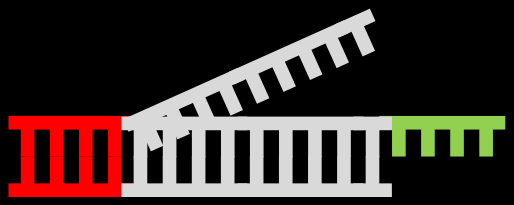
[Source: https://www.youtube.com/watch?v=_cEkIwMYypo&t=11s]

Toehold-Mediated Strand Displacement

input

Component

Toehold-Mediated Strand Displacement



Component

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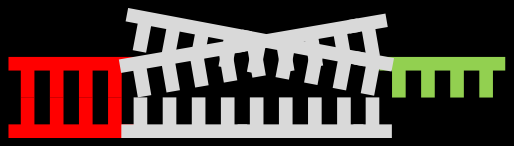

Component

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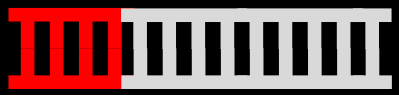
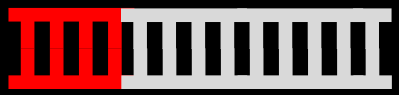


Component

output

Toehold-Mediated Strand Displacement



Component

output

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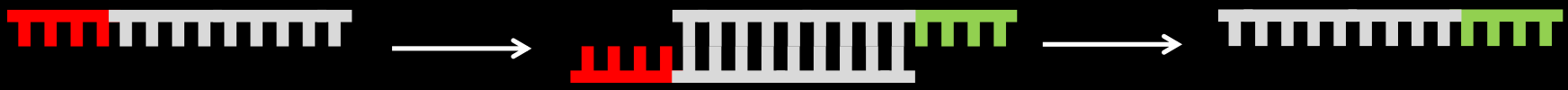
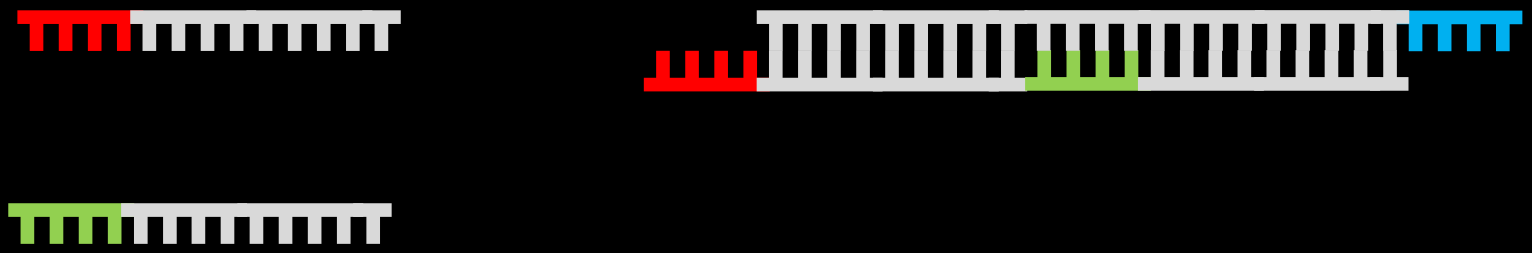


input Component output

TMSD Logic: AND

AND: **A** and **B** = **C**



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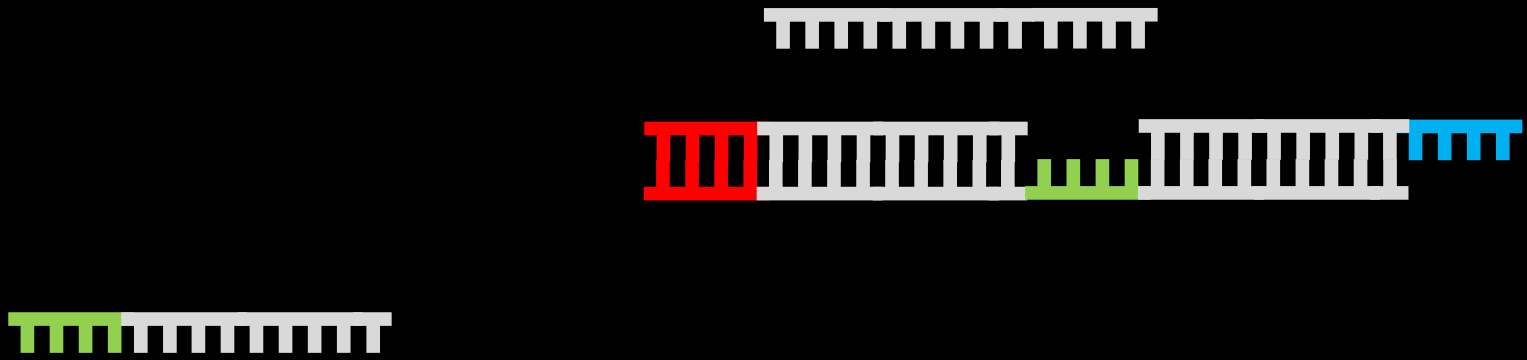

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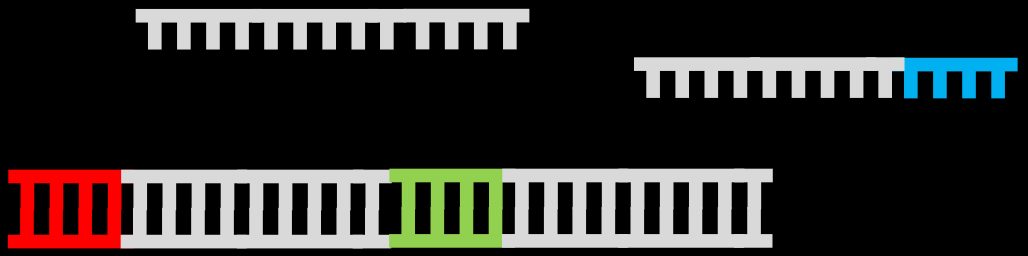

TMSD Circuits: Scaling

- Cascading Logic
- 4-bits quare-root circuit using 130 DNA strands
- Simple neural network

Thank You!

Acknowledgements

- Luca Pezzarossa
- Georgi Tanev
- Joel A.V Madsen
- Alexander M. Collignon,