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Ant routing for the Lightning Network (with C. Grunspan)

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Building on Bitcoin

Lisbon

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Ant routing for the Lightning Network

1 Decentralized Networks

- 2 Lightning Network.
- 3 Biological ant routing
- 4 Basic ant routing for LN

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Basic ant routing for LN

The Lightning Network.

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The Lightning Network.



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Basic ant routing for LN

Liberté, Égalité, Diversité, Vérificabilité

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Necessary conditions for decentralization:

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Necessary conditions for decentralization:

Open and affordable access to the network. Liberté

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Image: A matrix

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- Nobody trusts anyone, everyone verifies. Vérificabilité

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• Payment channels: Allow off-chain transactions.

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- Payment channels: Allow off-chain transactions.
- One Initial Commitment Transaction and one Settlement Transaction are the only on-chain transactions.

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Image: A matrix

Payment channels

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(Nakamoto, Hearn, Spilman, Decker, Wattenhofer, Dryja, Poon, Prihodko, Ostrovskyi, Sahno, Zhigulin, Russell, Osuntokun,...)

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Main problem: Decentralized payment path finding algorithm.

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Problems and difficulties

• Global knowledge of the geometry of the network is a vector of attack.

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- Solutions based on "beacon nodes" with rich routing tables.

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- Global knowledge of the geometry of the network is a vector of attack.
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- Beacon nodes or supernodes violate decentralization.

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• Bitcoin network does not use routing tables. Information (transactions) are propagated to the whole network.

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Ant paths

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Figure 1.1

Experimental setup for the double bridge experiment. (a) Branches have equal length. (b) Branches have different length. Modified from Goss et al. (1989).



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• Marking paths with pheromones.

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- Marking paths with pheromones.
- Reinforcing paths with pheromones.

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Ariadne's thread

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Pheromone seeds

• Alice wants to pay Bob. They agree on a common random number *R*.

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- Alice's pheromone seed $S(A) = 0^{-}R$.

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- Alice wants to pay Bob. They agree on a common random number *R*.
- Alice's pheromone seed $S(A) = 0^{\frown} R$.
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- Derived seed: If $S = X^{\frown}R$, the derived seed is S' = R.

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- Alice, resp. Bob, propagates S(A), resp. S(B), to neighbors.

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Basic ant routing for LN

Propagation and matching

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Propagation and matching

• A node that receives a pheromone seed S notes from which neighbor it arrived and checks if S or \overline{S} was received before.

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• A node that receives a pheromone seed S notes from which neighbor it arrived and checks if S or \overline{S} was received before.

• If none was received, it stores *S* in the mempool and propagates to other neighbors.

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• If *S* is not in the mempool but \overline{S} is, then a matching occurs. The node constructs the matched seed $S_m = 0^{\frown} S(A)$ and propagates it to the neighbors that send the pheromone seeds S(A) and S(B).

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Confirmation and payment

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Confirmation and payment

• Alice waits for several matched seed to arrive, and chooses one and constructs the confirmed seed $S_c = 0^{-}S_m$.

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- Nodes that receive a confirmed seed propagate it back.

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- Once Bob receives the confirmed seed, he signals it to Alice and the payment is initiated through that path.

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- Alice and Bob enrich the pheromone seed by adding:
 - An amount field.

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- Alice and Bob enrich the pheromone seed by adding:
 - An amount field.
 - A maximal fee field.

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Mempool management

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Self-improvement features

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Self-improvement features

• The topology of the network is dynamical.

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- The topology of the network is dynamical.
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- Nodes can store historical performance of neighbors and compute some weighting.
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- Best analysis will increase traffic and profitability.

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R. Pérez-Marco

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Ant routing for the Lightning Network (with C. Grunspan)

Thank for your attention!

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