Distributed Systems

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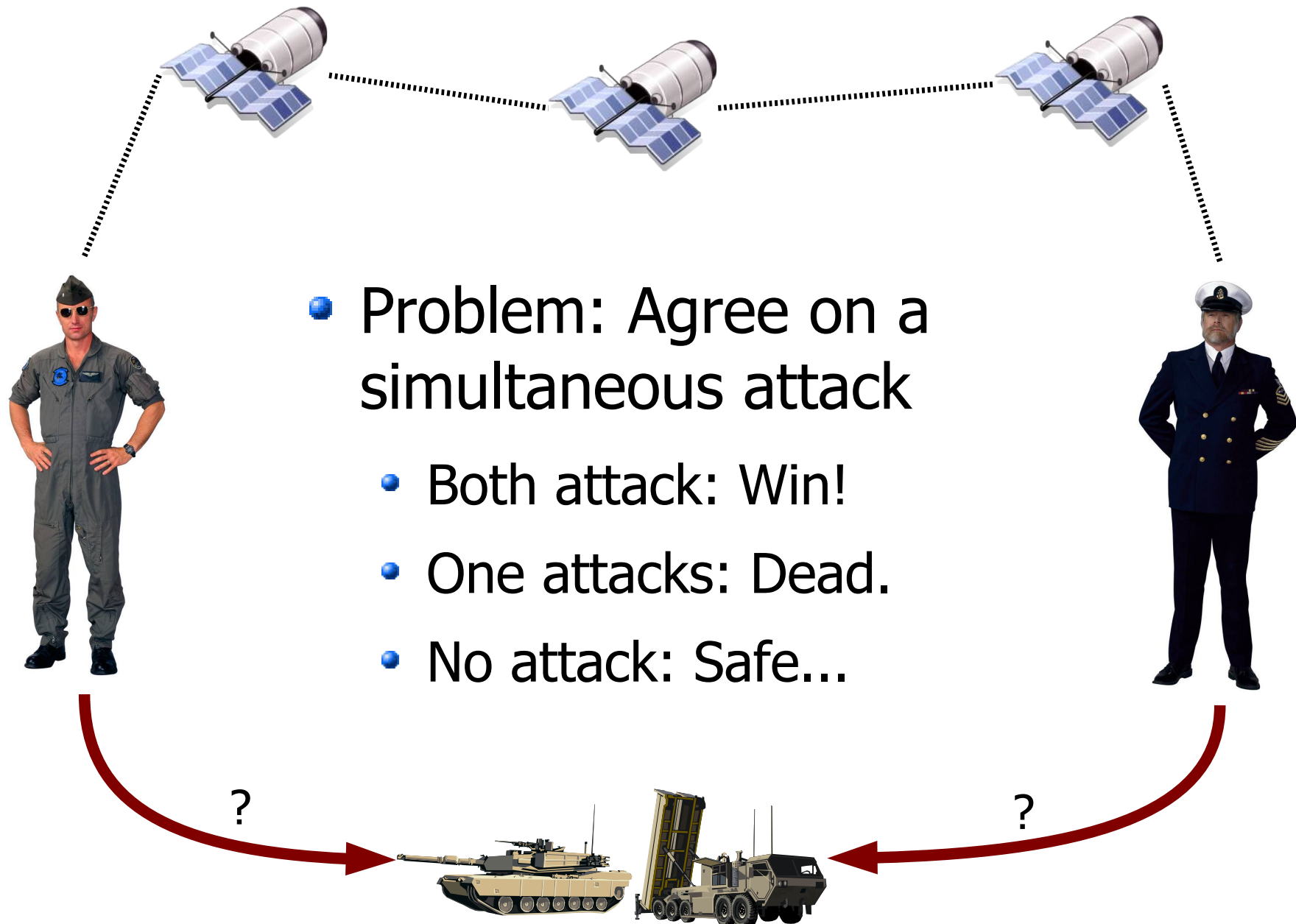
Goals

- Discover what is true in a distributed system:

  - For an external observer: "It works!"
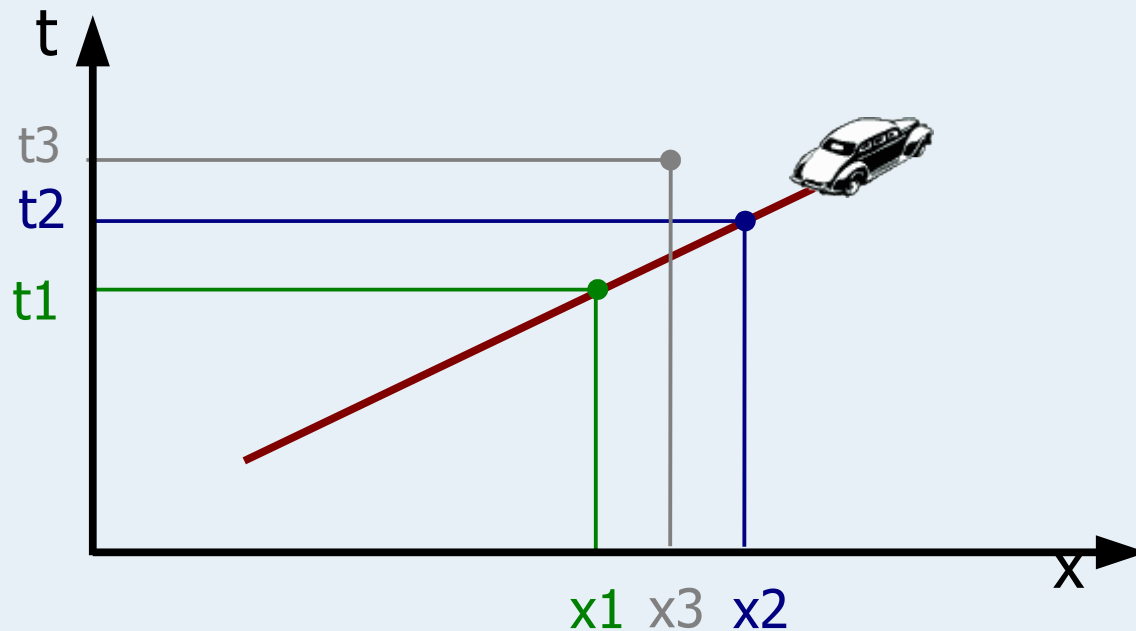
  - From within the system: "I'm done!"

More goals

- Build intuition on distributed systems

- Programming concurrent servers:

  - Multi-threaded

  - Event-driven

Example: Coordinated attack

- Problem: Agree on a simultaneous attack
  - Both attack: Win!
  - One attacks: Dead.
  - No attack: Safe...

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An analogy...

1) Variables:
x – position
t – time

2) Observations:
t=t1, x=x1
t=t2, x=x2

3) Observations can be generalized by an equation with a common format:
$x = x0 + vt$

Example: Coordinated attack

- Consider just messages sent and messages received

- Alternatives:

  - Messages received = messages sent

  - Messages received $\subseteq$ messages sent

  - Any messages received

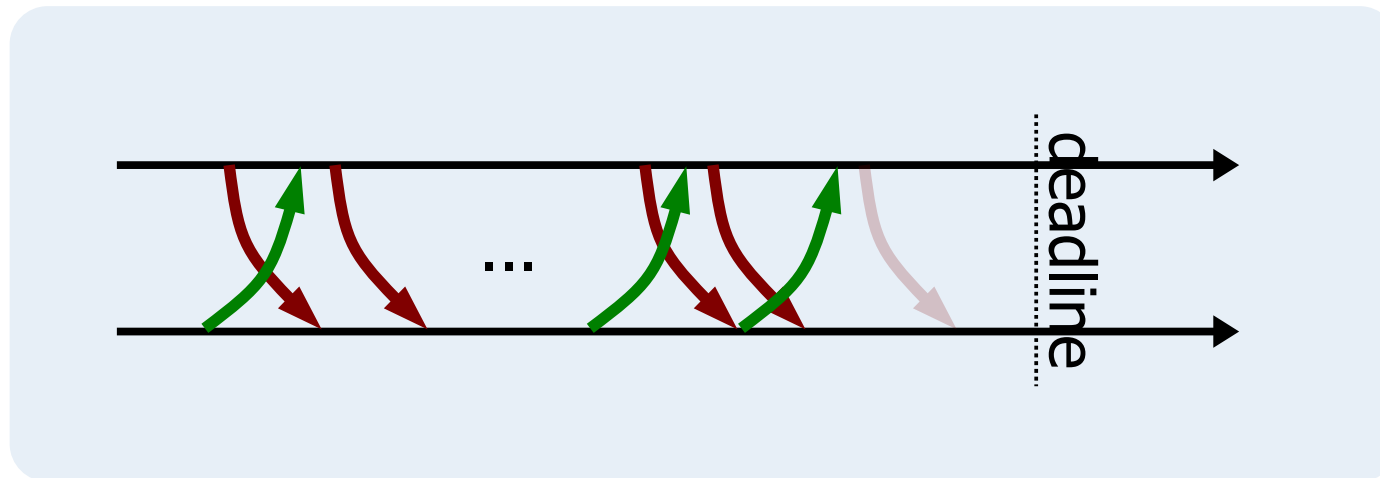- Does it work?

Example: Coordinated attack

- Interesting case: Messages received is a subset of messages sent

- Consider an hypothetical solution:
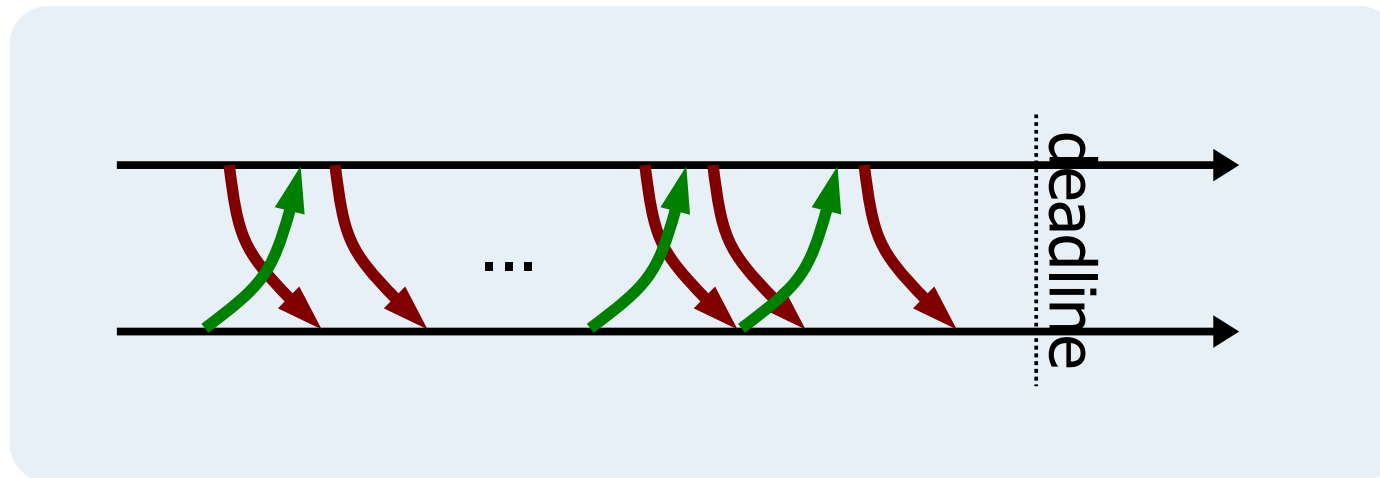
- Does the last message matter?

Example: Coordinated attack

- It doesn't matter:

  - It can be lost

  - The sender has already decided

- And now, does the next message matter?

Example: Coordinated attack

- We discover that no distributed program can solve the problem

- Consequences:

  - How to draw money from an ATM? See <u>Transactional Distributed Systems</u>

  - How to fly an airplane with redundant controllers? See <u>Fault Tolerance</u>

- How to generalize the approach?

Case study: Trading system

- Input: offer to buy or sell something

- No output until a suitable buyer/seller pair is found

  - The trading system never holds stock

- Output: confirmation

Case study: Trading system

- ## What matters:

  - ### We don't buy/sell more than what has been offered/requested

  - ### If there are sellers and buyers for at least k items, eventually k items are sold and bought

  - ### If multiple buyers/sellers are competing, make sure no one is left behind

- ## What doesn't matter:

  - ### How the server is implemented

  - ### If there is a server at all...

  - ### ...