Cryptography and Blockchains: Building the Bedrock of Information Society

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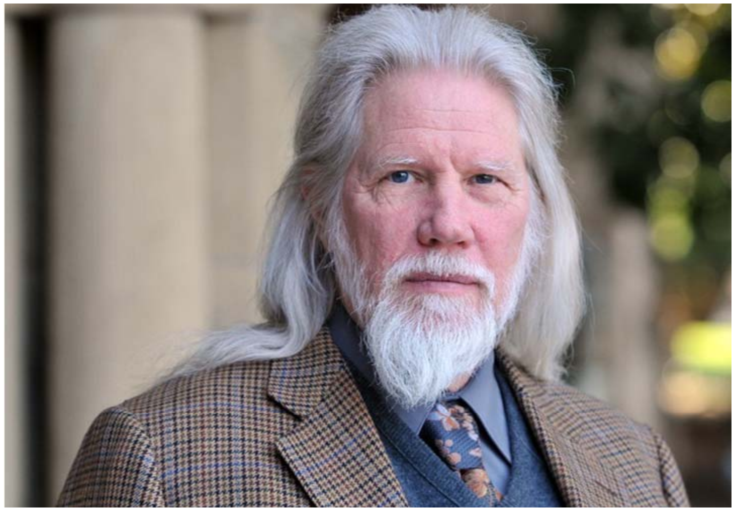
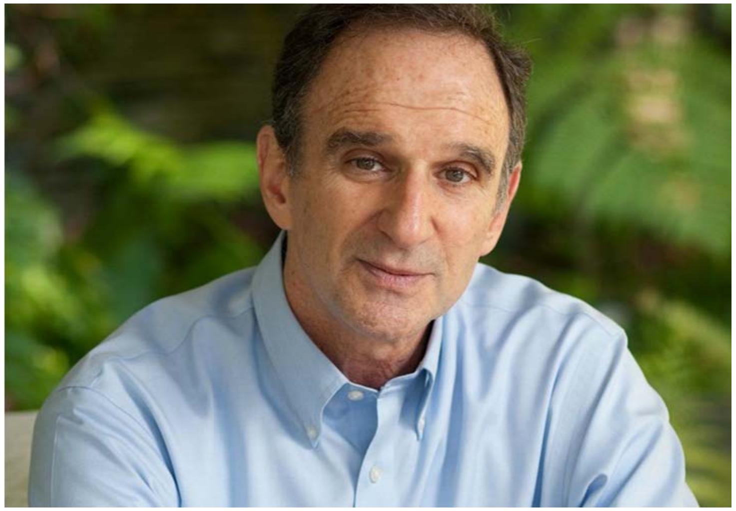
ETH Zürich

Univ. of Copenhagen, June 24, 2019, Copenhagen.





Whitfield Diffie (*1944)

Martin Hellman (*1945)

Inventors of public-key cryptography

James Massey (1934 USA – 1913 Copenhagen)

Founder of the IACR
(International Association for Cryptologic Research)

Peter Landrock (born 1948)

Eminent Danish cryptographer

physical objects $\rightarrow$ **digital objects**

physical objects → digital objects

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Effect of digital objects in the real world:

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Effect of digital objects in the real world:

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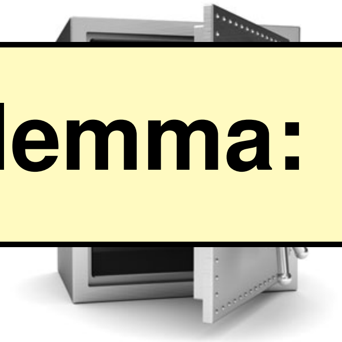
- launch a nuclear missile
- trigger the end of humanity ....

physical objects → digital objects



Dilemma: functionality ↔ security

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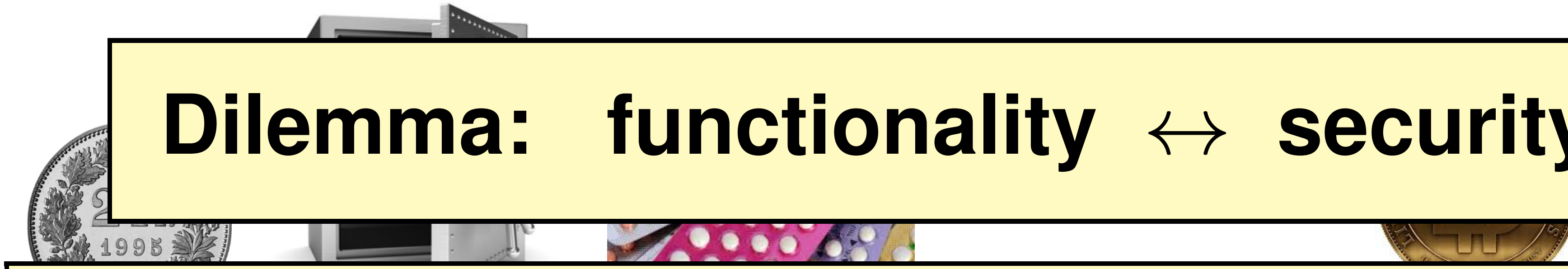

Dilemma: functionality $\leftrightarrow$ security

Functionality: One can efficiently decrypt using the key.

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Effect of digital objects in the real world:

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Dilemma: functionality ↔ security

Functionality: One can efficiently decrypt using the key.

Security: One can **not** efficiently decrypt without the key.

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physical objects → digital objects




Dilemma: functionality ↔ security

Functionality: One can efficiently decrypt using the key.

Security: One can **not** efficiently decrypt without the key.

⇒ One cannot test or measure security.
One can only prove it (mathematically).

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Information security: 2 types

1. **“Protective” security**

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   - defensive view
   - protect against system flaws and attacks
   - mission of software design/ formal methods

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3 dilemmata:

- Functionality/security tradeoff dilemma
- Specification complexity dilemma
- Implementation impossibility dilemma

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2. **Construction of virtual trusted systems**
   - mission of **cryptography**
   - virtual systems are also **economic systems**

Virtual Trusted Systems

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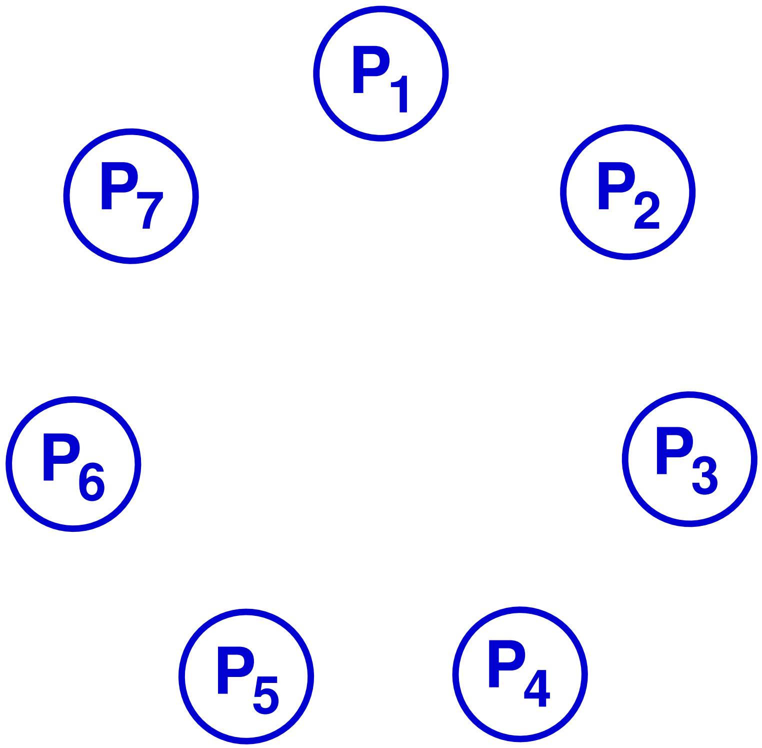

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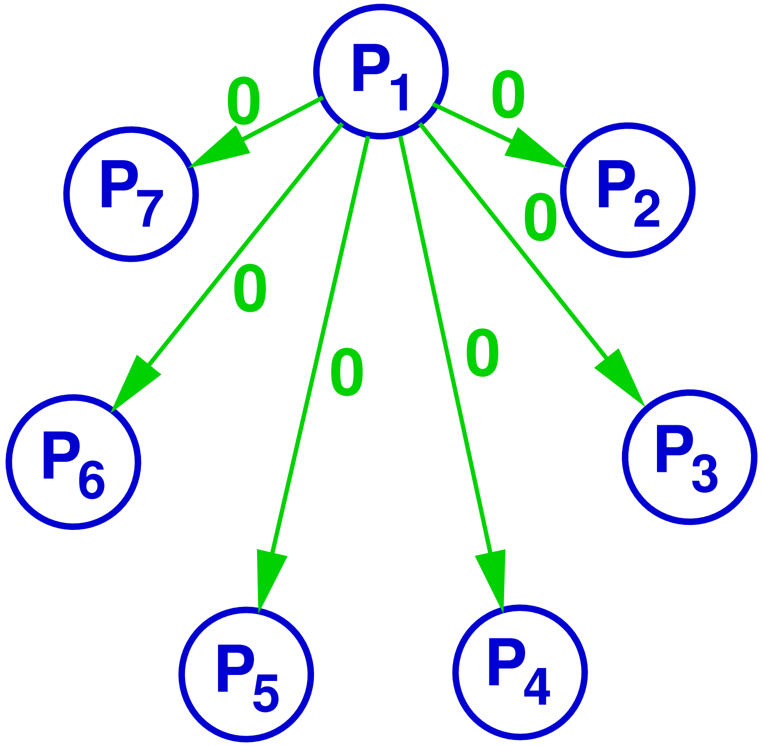

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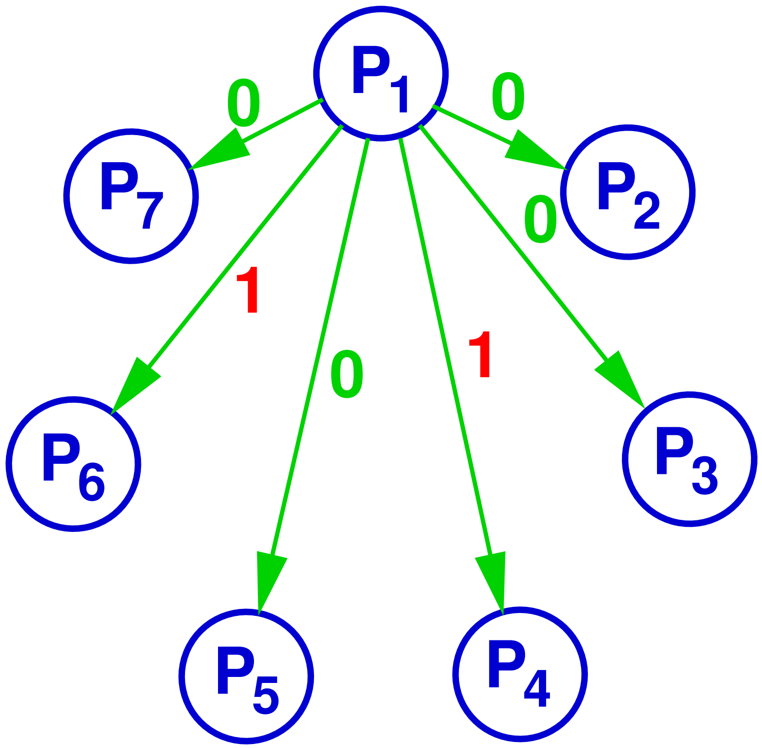

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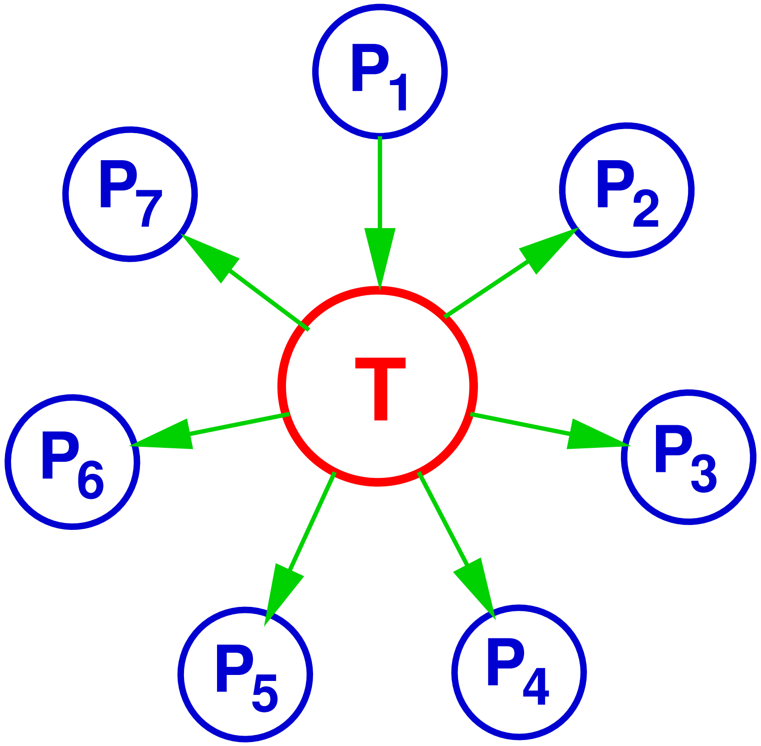

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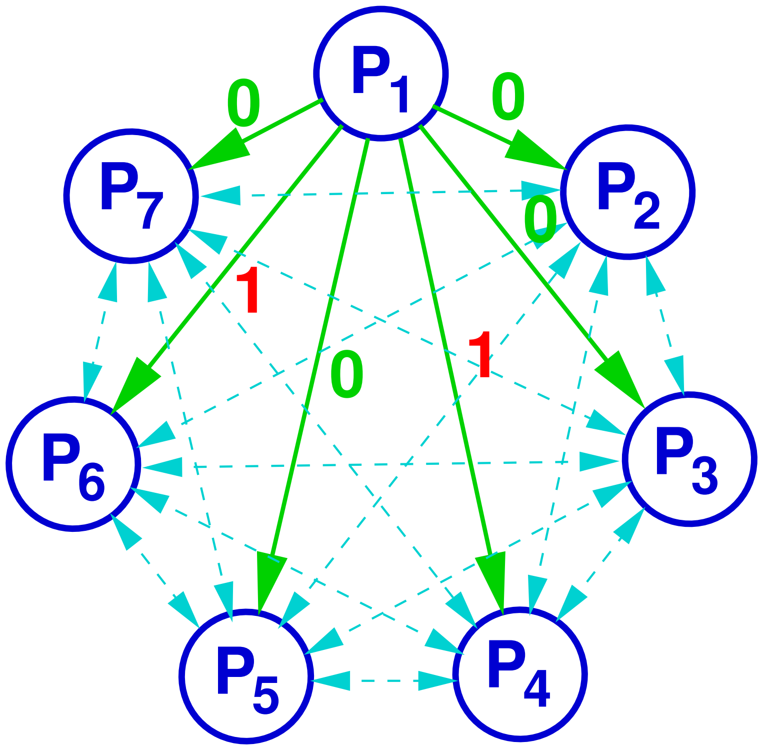

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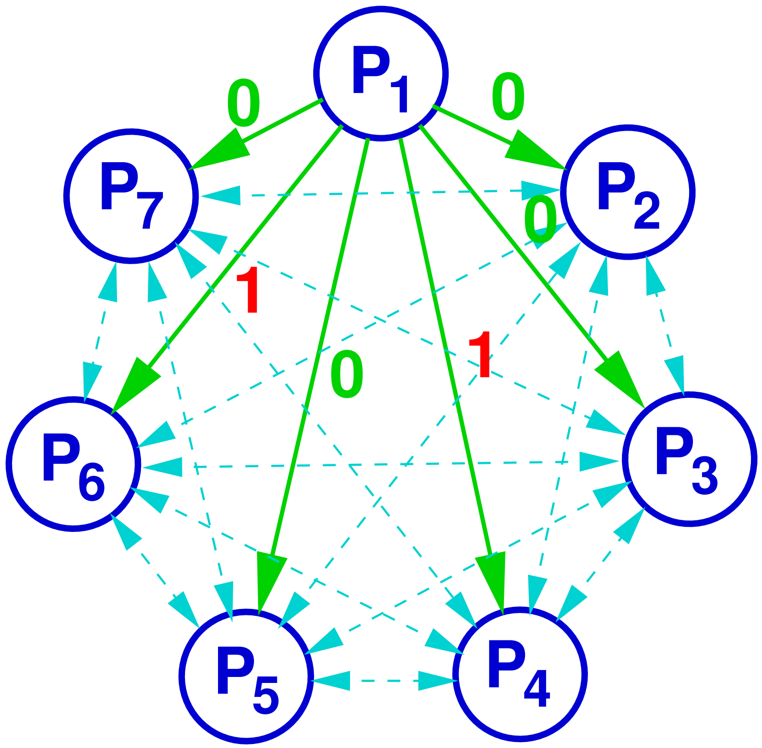

Theorem [LSP80]: This is possible if and only if less than 1/3 of the parties are corrupted.

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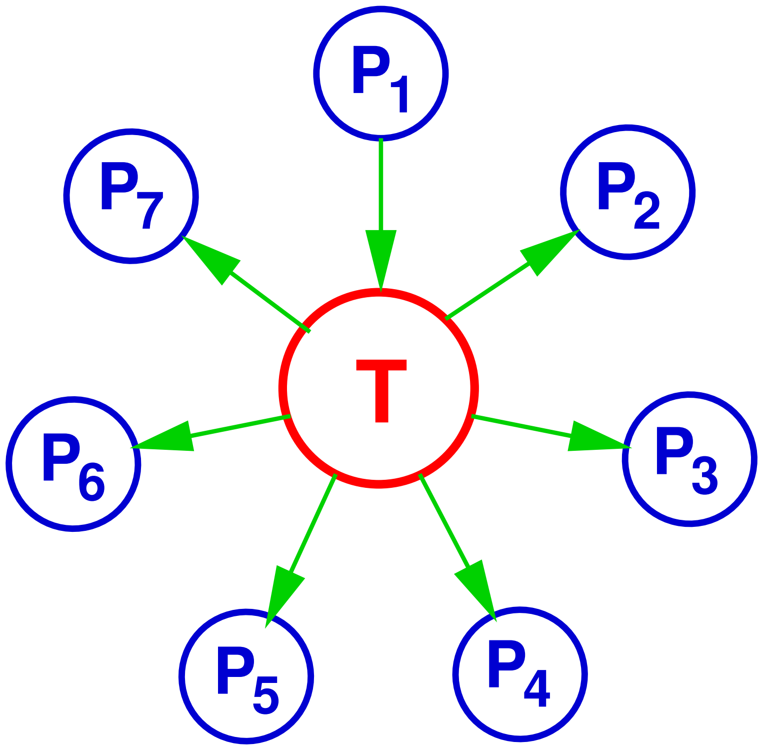

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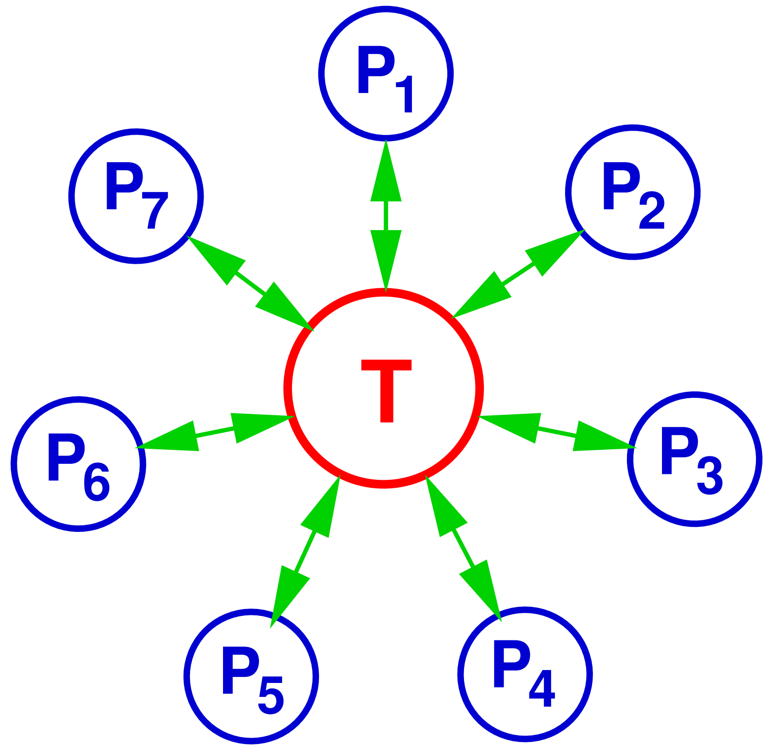

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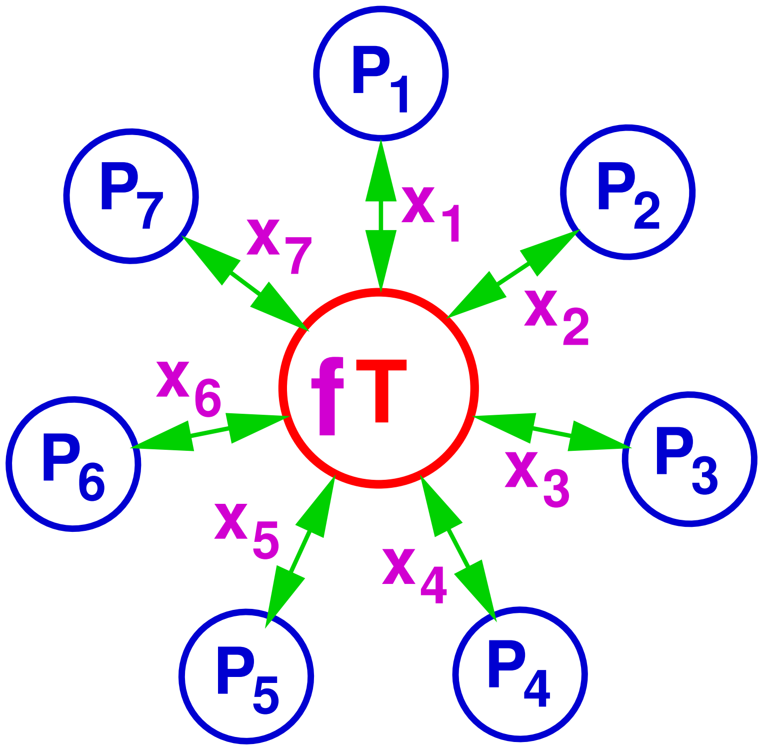

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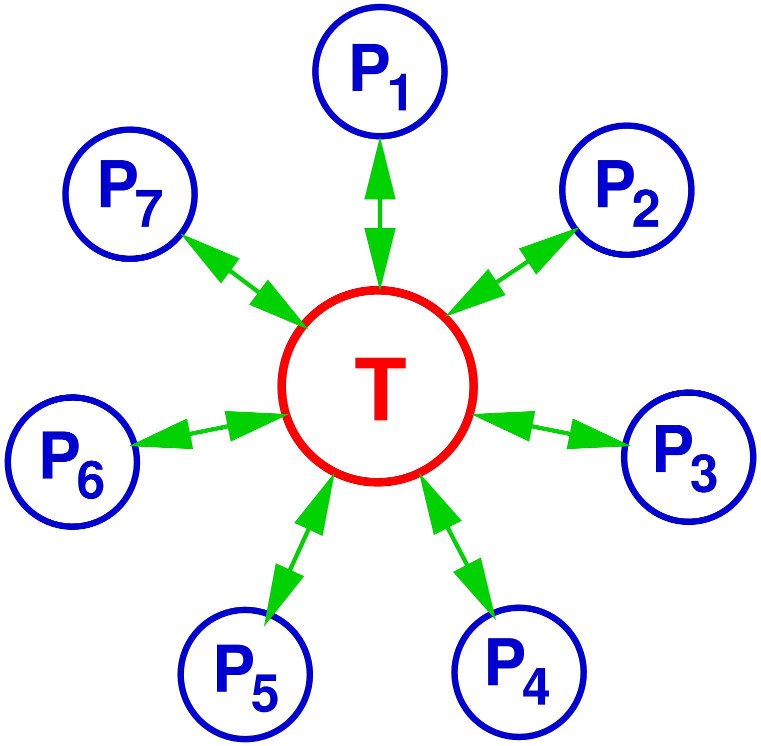

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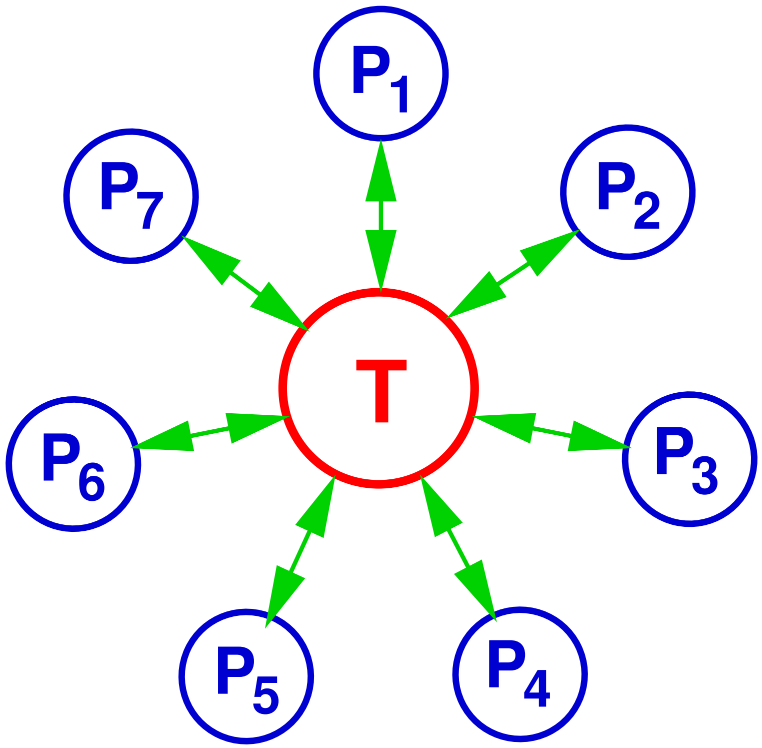

Examples: T can be a

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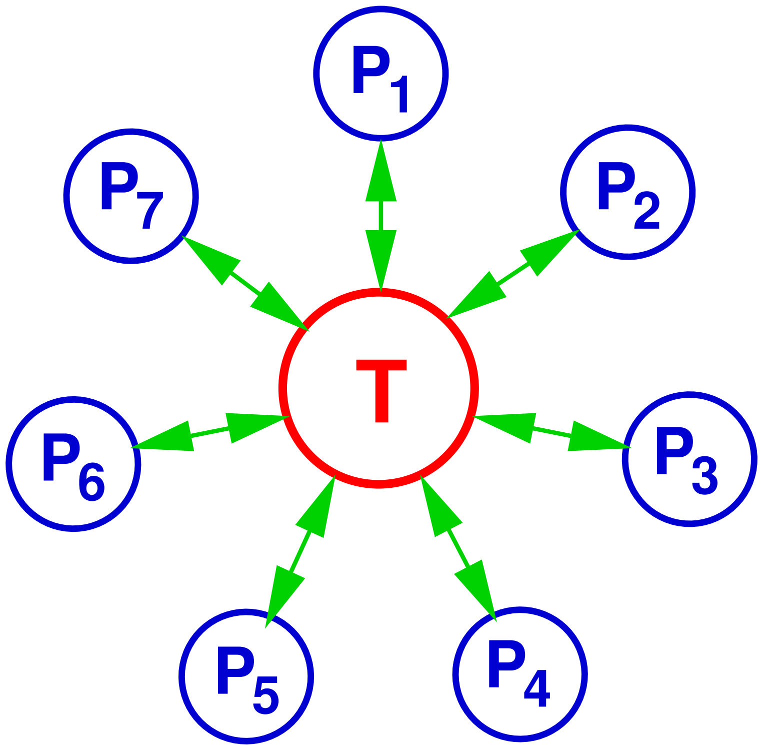

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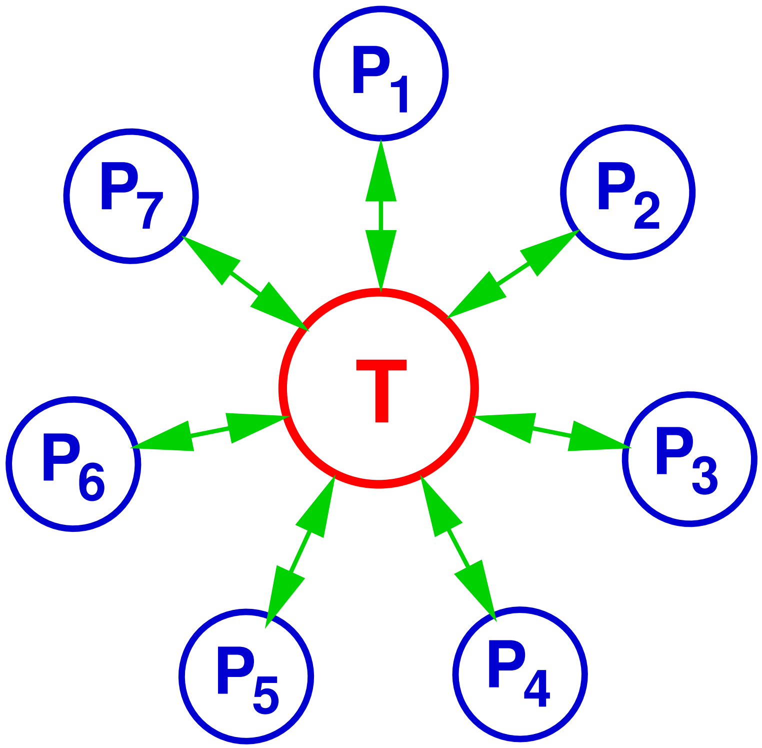

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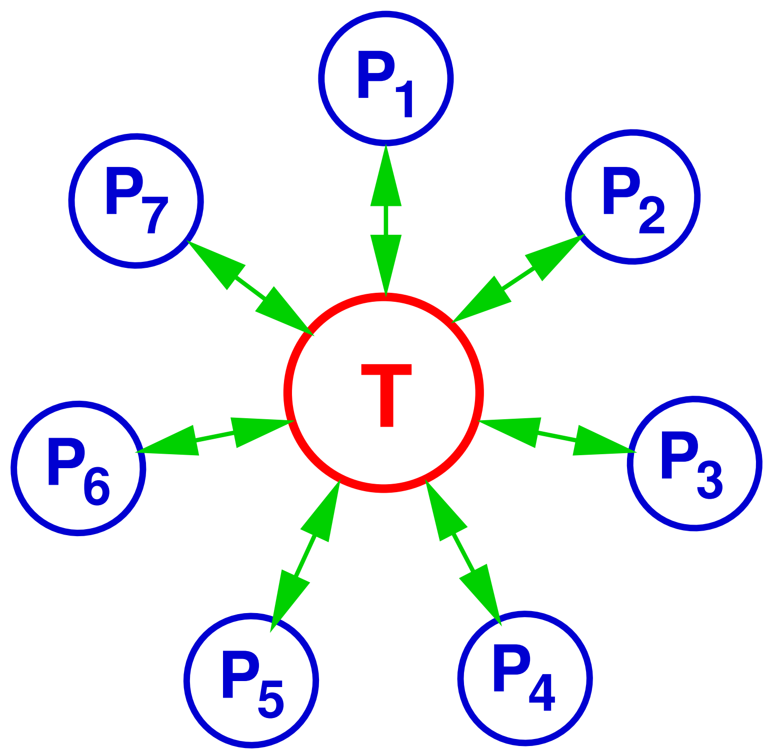

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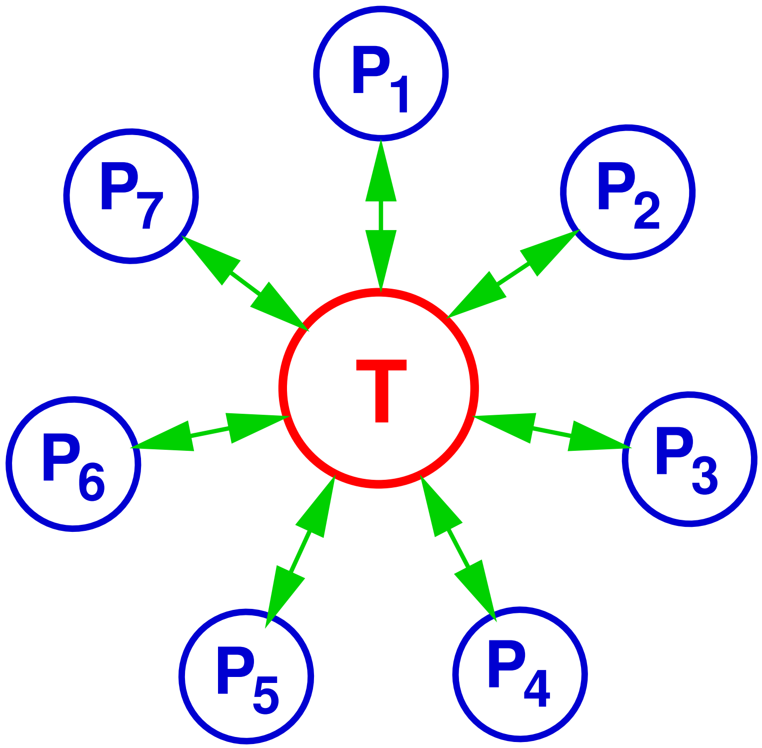

Examples: T can be a

- a secure channel between 2 entities
- voting system
- virtual central bank
- programmable transaction system

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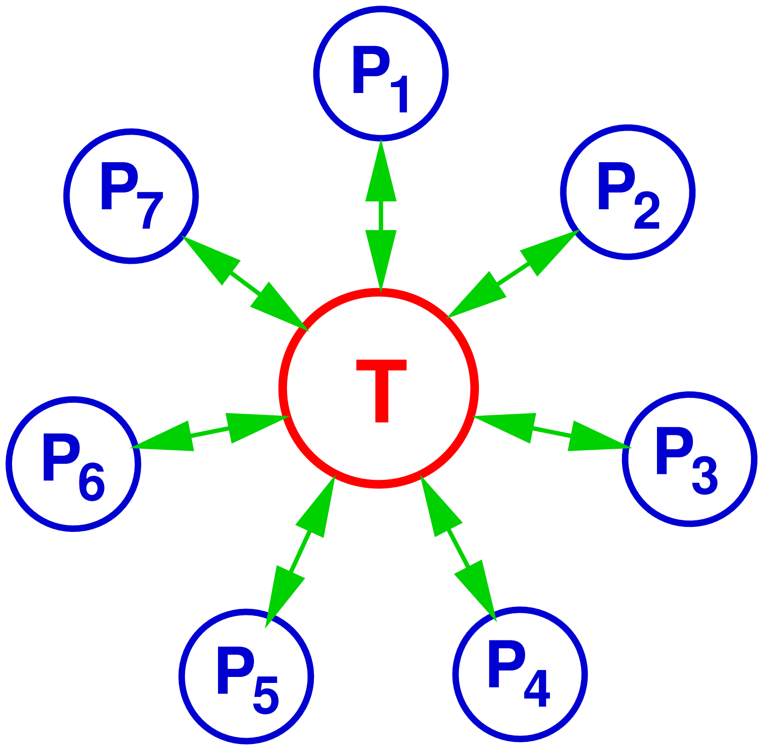

Scientific techniques:

- Consensus and Byzantine agreement protocols
- Secure multi-party computation (MPC)
- Blockchain protocols

Final remarks

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- Pro-control vs. anti-control dispute

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  of constructing virtual systems
- Economic science of virtual system construction
- We have only (or not even) seen the tip of the iceberg.
- Versatile transaction systems
- Autonomous digital objects
- Pro-control vs. anti-control dispute
- Denmark and Switzerland are leading nations in this space.

Thank you!