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** Measure of the economic attractiveness of a technology typically determined by comparing its costs and benefits from a perspective of a certain stakeholder.*

Feasibility* analysis of new Internet protocols

Deployment of Internet protocols

Internet protocols are networked innovations developed at the IETF

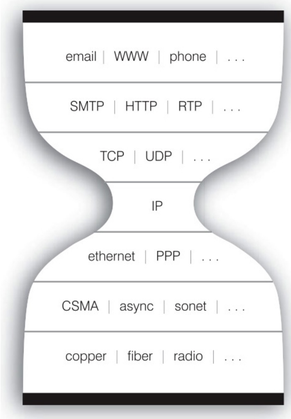
Internet is a challenging environment for protocol deployment

- ✓ Distributed and unregulated → market-based deployment
- ✓ Various stakeholders with diverse economic goals → tussles
- ✓ Significant network effects → bootstrap problem (in the beginning: costs > benefits)

The success rate of Internet protocols is not very good

- ✓ RFC 5218: *A successful protocol is one that is used for its original purpose and at the originally intended scale*.

Reason: Stakeholders' incentives and the dynamics of deployment not sufficiently understood during protocol development



How to improve protocol feasibility?

Analyze feasibility systematically from the beginning of development

→ Identify and solve the deployment problems early

Translate technical design to costs & benefits

→ Techno-economic analysis – one step further from technical performance analyses

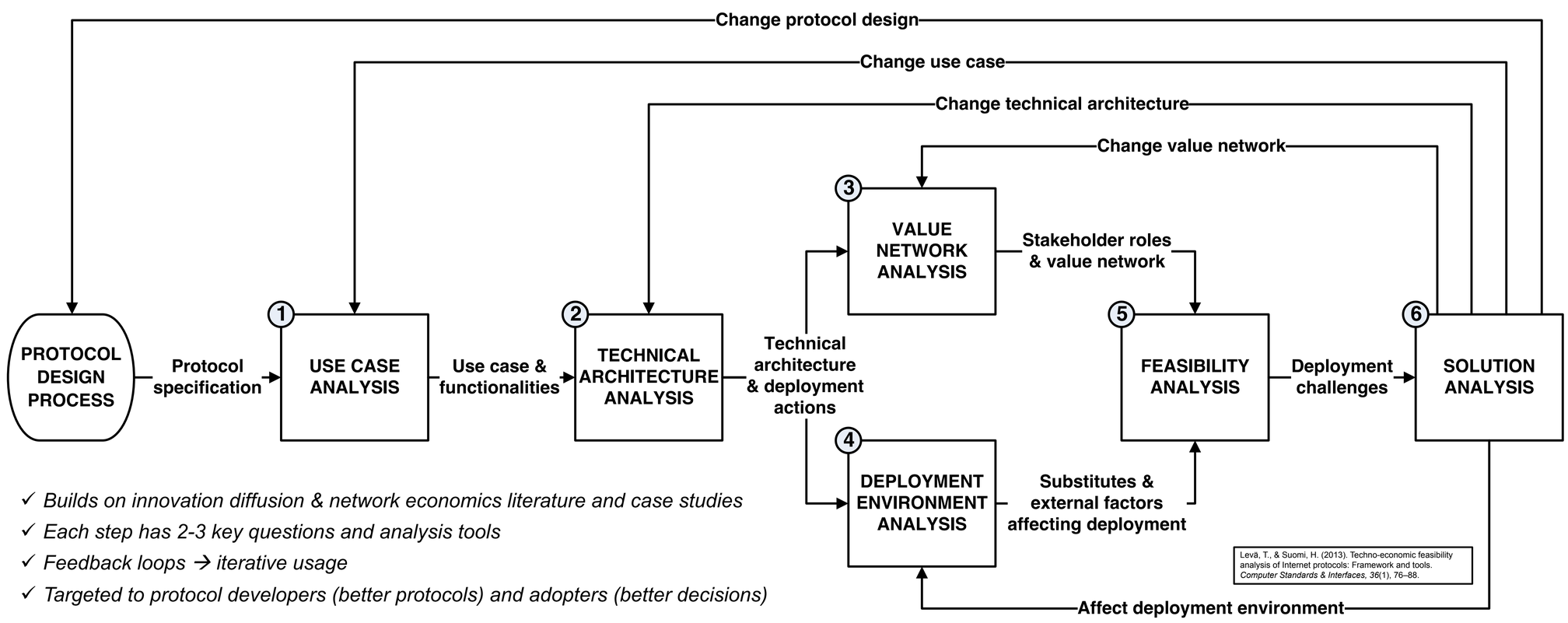
Cover all the relevant stakeholders of the whole deployment process

→ *Protocol deployment is a process during which a protocol is advanced from the specifications into actual use on the Internet*

Build cross-disciplinary analysis teams

→ Collaboration between protocol developers and business experts

Feasibility analysis framework

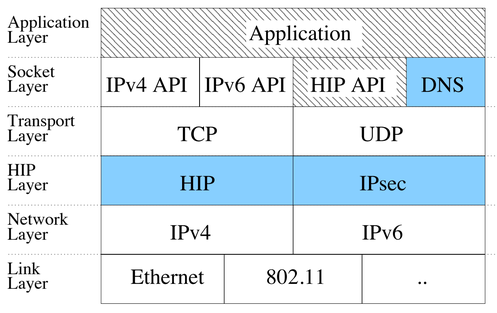


- ✓ *Builds on innovation diffusion & network economics literature and case studies*
- ✓ *Each step has 2-3 key questions and analysis tools*
- ✓ *Feedback loops → iterative usage*
- ✓ *Targeted to protocol developers (better protocols) and adopters (better decisions)*

Why has HIP not been deployed yet?

Host identity protocol (HIP)

- ✓ Loc/ID split protocol introducing host identity namespace based on cryptographic identifiers
- ✓ Improves security, mobility, NAT traversal, and IPv4-IPv6 interoperability
- ✓ Developed since 1999, deployment minimal



Research method

- ✓ 19 in-depth expert interviews

Deployment barriers

1) Low demand for the functionalities of HIP
2) Substitutes were earlier in the market
3) Substitutes have (perceived) relative advantage
4) Lack of early adopter benefits necessitates costly coordination
5) People have misconceptions about the deployability of HIP
6) Research-mindedness has lead to strategic mistakes and non-optimal design choices

Strategies to foster deployment

- ✓ Focus on the most promising use cases (#1, #3)
- ✓ Co-deploy HIP with an application or as a library with API (#3, #4)
- ✓ Bust the myths, educate, and market (#5, #6)

Levä, T., Komu, M., Keränen, A., & Luukkainen, S. (2013). Adoption barriers of network-layer protocols: The case of host identity protocol. *Computer Networks, 57*(10), 2218–2232.

Cost-efficiency of CoAP vs. HTTP

Constrained application protocol (CoAP)

- ✓ Application layer protocol for the Internet of Things
- ✓ Simple alternative for HTTP with smaller communication overhead and requirements for processing power and memory
- ✓ Several implementations, limited deployment

Research method

- ✓ Total cost of ownership analysis

CoAP is more cost-efficient than HTTP in application scenarios where

- ✓ The number of smart objects is high (*cheaper hardware*)
- ✓ Smart objects communicate frequently and sleep between communication sessions (*smaller power consumption*)
- ✓ Smart objects are deployed in the field (*smaller battery replacement costs*)
- ✓ Charging for data communications is volume-based (*smaller communication overhead*)

Levä, T., Mazhelis, O., & Suomi, H. (In Press). Comparing the cost-efficiency of CoAP and HTTP in web of things applications. *Decision Support Systems*, Available online 25 September 2013, DOI: 10.1016/j.dss.2013.09.009.

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