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Framework for analyzing the feasibility of Internet protocols

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IAB Workshop on Internet Technology Adoption and Transition (ITAT)
December 4-5, 2013, Cambridge, UK

Presentation is based on a paper published at Computer Standards & Interfaces journal:

> *Levä, T., & Suomi, H. (2013). Techno-economic feasibility analysis of Internet protocols: Framework and tools. Computer Standards & Interfaces, vol. 36, no. 1, pp. 76-88, DOI: 10.1016/j.csi.2013.07.011.*

Background and motivation

Internet is a challenging environment for innovation diffusion

- distributed and unregulated –> market-based diffusion
- various stakeholders with diverse economic goals –> tussles
- significant network externalities –> bootstrap problem

The success rate of Internet protocols is not that great

- RFC 5218: *A "successful" protocol is one that is used for its original purpose and at the originally intended scale.* (Thaler & Aboba, 2008)

Existing literature valuable but has some limitations

- *Generic protocol design principles* focus on technical issues and fail to account for the special characteristics of each protocol
- *Retrospective case studies* cannot affect protocol design and typically limit on the potential end users

Thaler, D., & Aboba, B. (2008). **What Makes for a Successful Protocol?** RFC 5218 (Informational), July 2008.

How to improve protocol success rate?

Analyze feasibility systematically from the beginning of protocol development

- Identify and solve the deployment problems early

Translate technical design to costs & benefits = techno-economic

- One step further from technical performance analyses

Cover all relevant stakeholders of the whole deployment process

- Deployment defined as *a process during which a protocol is advanced from the first specification into actual use on the Internet*

Build cross-disciplinary analysis teams

- Collaboration between protocol developers and business experts

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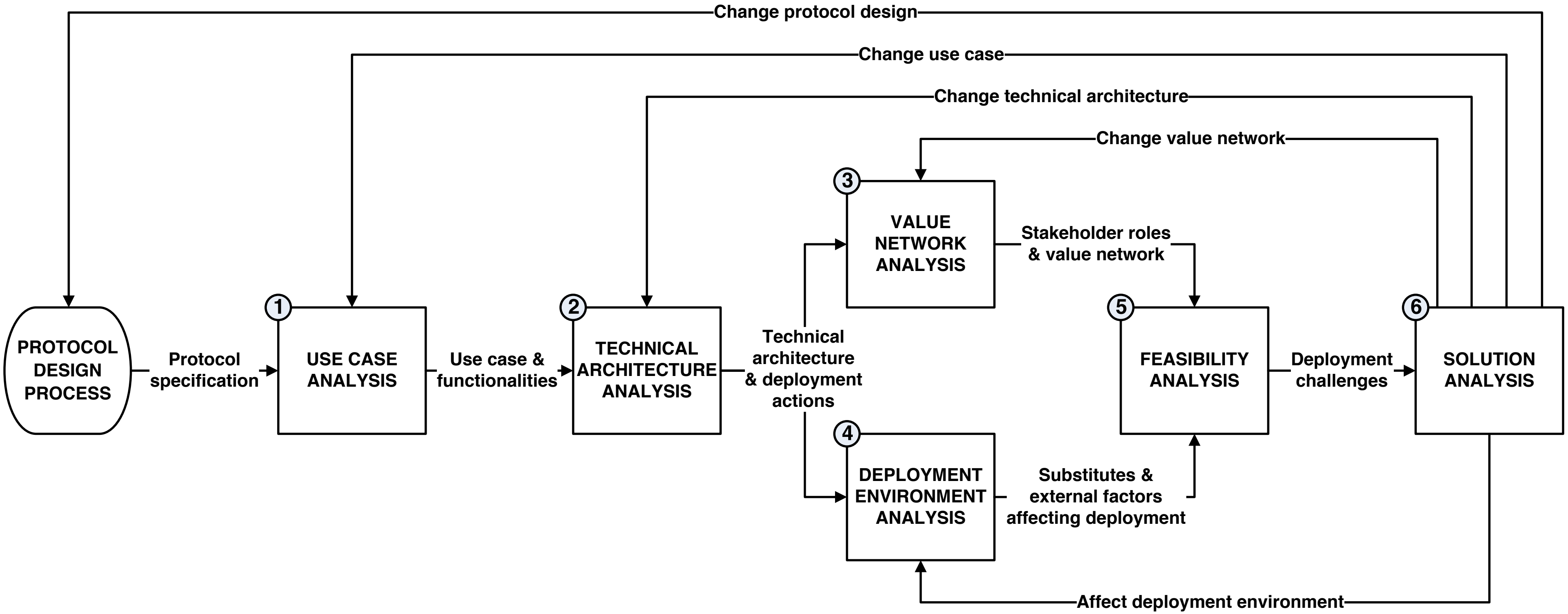
Framework for feasibility analysis



Builds on diffusion theories and case studies

Each step has 2-3 key questions + tools

Feedback loops → iterative usage

Accessible, flexible, focus can vary

Example of key questions - Step 5: Feasibility analysis

- Does the protocol demonstrate positive net benefits for all the relevant stakeholders?
- How do network effects impact on the formation of costs and benefits?
- What are the deployment challenges of the protocol?

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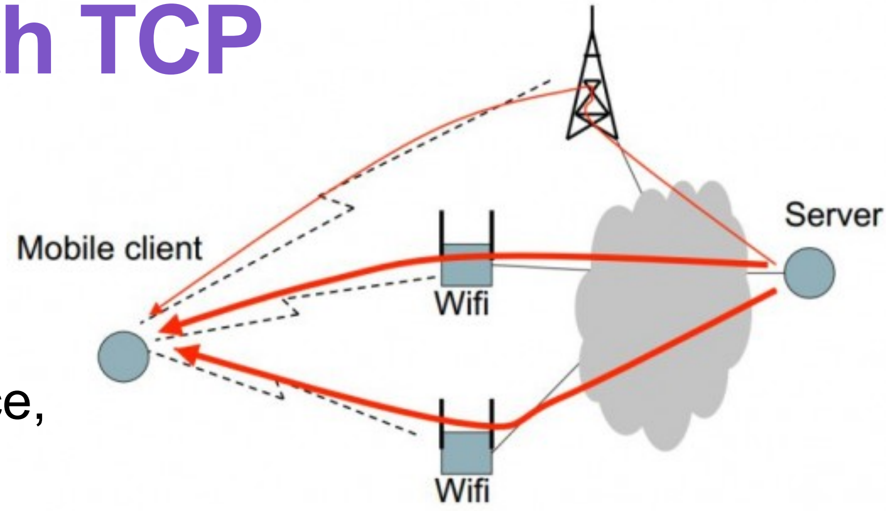
Case 1 – MPTCP

Feasibility of Multipath TCP

Multipath TCP

- Splits the traffic of one TCP flow into multiple subflows
- Improves throughput and resilience, enables seamless handovers



Feasibility analyzed from multiple perspectives

- Technical architecture and value network alternatives (Levä et al., 2010)
- Deployment challenges and solutions (Kostopoulos et al., 2011)
- Dynamics of diffusion, cross-side network effects (Warma et al., 2011)
- Value of multipath protocols to end users (Suomi et al., 2012)
- Techno-economic modeling of specific use cases (Warma et al., 2010; Sonntag & Suomi, 2013);

Levä, T., & Suomi, H. (2013). **Techno-economic feasibility analysis of Internet protocols: Framework and tools.** Computer Standards & Interfaces, vol. 36, no. 1, pp. 76-88.

Case 1 – MPTCP

Deployment challenges and solutions

Potential deployment challenges

1. Single-path capacity suffices
2. OS vendors unwilling to implement and maintain MPTCP code
3. Chicken-and-egg problem between the client and server sides

Solutions to the identified challenges

- Application implementation (#1, #2)
- Lobbying (#2)
- Open source implementation of MPTCP (#2)
- Both ends in one hand (e.g., Apple's iOS 7 uses MPTCP with Siri) (#3)
- Proxy implementation (#3)

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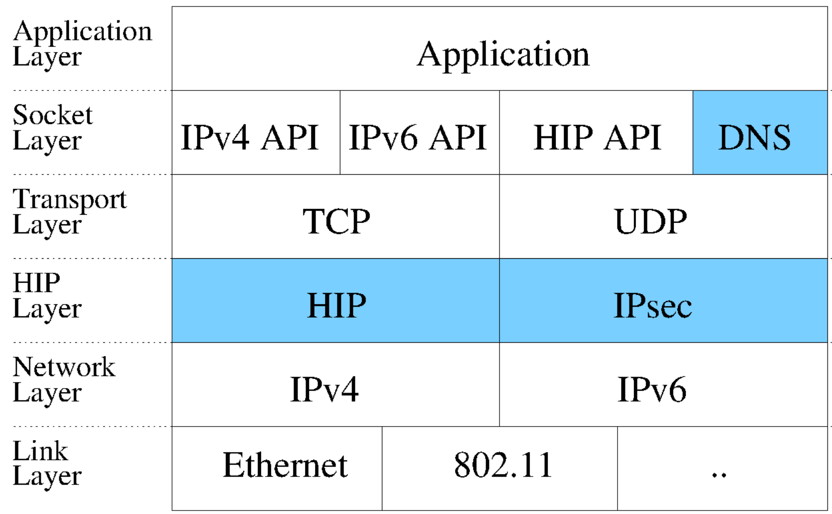
Case 2 – HIP

Feasibility of Host Identity Protocol

Host Identity Protocol

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



Research question: Why has HIP not been widely deployed yet?

Research method: 19 in-depth expert interviews

Levä, T, Komu, M., Keränen, A., & Luukkainen, S. (2013). **Adoption Barriers of Network-layer Protocols: the Case of Host Identity Protocol.** Computer Networks, vol. 57, no. 10, pp. 2218–2232.

Case 2 – HIP

Reasons for non-deployment

1) **Demand for the functionalities of HIP has been low.**

Where demand has existed, substitutes have been favored because:

2) **Substitutes were earlier in the market,**
3) **Substitutes have (perceived) relative advantage due to some design choices of HIP,**
4) **Lack of early adopter benefits necessitates costly coordination,**
5) **People have misconceptions about the deployability of HIP, and**
6) **Research-mindedness of HIP developers has lead to strategic mistakes and non-optimal design choices.**

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Case 2 – HIP

Strategies to foster HIP deployment

Focus on the most promising use cases (#1, #3)

- Private, single-stakeholder, deployment scenarios
- Military, public safety, industrial control systems, sensors

Co-deploy HIP with an application or as a library (#3, #4)

- Bypass OS vendors, improve application control through APIs

Bust the myths, educate, market (#5, #6)

- Company-driven activity, preferably through real-life deployments
- Some parts of HIP could be re-used in other protocols

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Conclusion

The introduced framework…

- promotes systematic feasibility analysis during protocol development
- provides a list of key questions and tools
- allows early identification of deployment challenges
- facilitates deployment through solutions and feedback loops

The framework is targeted to:

- Protocol developers –> more deployable protocols
- Potential adopters –> more informed adoption decisions

Discussion: Conduct feasibility analysis in the IETF??

- Include "deployment considerations" in RFCs??

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Thank you!

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