

Choice as a Principle in Network Architecture*

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ABSTRACT

There has been a great interest in defining a new network architecture that can meet the needs of a future Internet. One of the main challenges in this context is how to realize the many different technical solutions that have developed in recent years in a single coherent architecture. In addition, it is necessary to consider how to ensure economic viability of architecture solutions. In this work, we discuss how to design a network architecture where choices at different layers of the protocol stack are explicitly exposed to users. This approach ensures that innovative technical solutions can be used and rewarded, which is essential to encourage wide deployment of this architecture.

Categories and Subject Descriptors

C.2.6 [Computer-Communication Networks]: Inter-networking; C.2.2 [Computer-Communication Networks]: Network Protocols—*Protocol architecture*

General Terms

Design

Keywords

network architecture, innovation, economics

1. INTRODUCTION

Much of the Internet's success comes from its ability to support a wide range of service at the edge of the network. However, the Internet offers little choice of service inside the network. It is widely agreed that this limitation inhibits the development and deployment of new networking services, protocols, security designs, management frameworks, and other components that are essential to support the increasingly diverse systems, applications, and communication paradigms of the next-generation Internet

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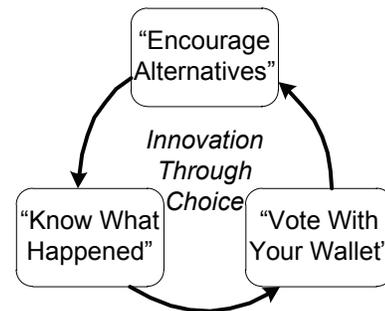


Figure 1: Foundational principles and their dependencies.

We believe that *choice* is the key aspect of a network architecture, and that it can drive innovations necessary for future networks. Choice implies that the entities using the network can select from a range of alternative services that may differ in functionality, performance, and cost. Choice can only arise if the network architecture supports the technology necessary for dynamic introduction of new alternatives. It is also necessary to put in place suitable economic processes to ensure that incentives trigger innovation and users can “vote with their wallets.”

In this poster, we describe the outline of a network architecture that can provide choice as a core principle.

2. CHOICE INSIDE THE NETWORK

Choices can appear at different layers in the protocol stack of a network, ranging from different communication paths to different protocols and application-layer services. Our system for a market-driven competition of networking functionality is based on three key principles (illustrated in Figure 1):

- **Principle 1: Encourage Alternatives.** The underlying network infrastructure must provide the building blocks to create different types of services and to create alternative services of the same type. Support for alternatives allows users to select the service(s) that best meets their needs, and provides the best performance for their application. Implicit in this principle is the idea that—in contrast to the present Internet, where competition exists only at the application layer,

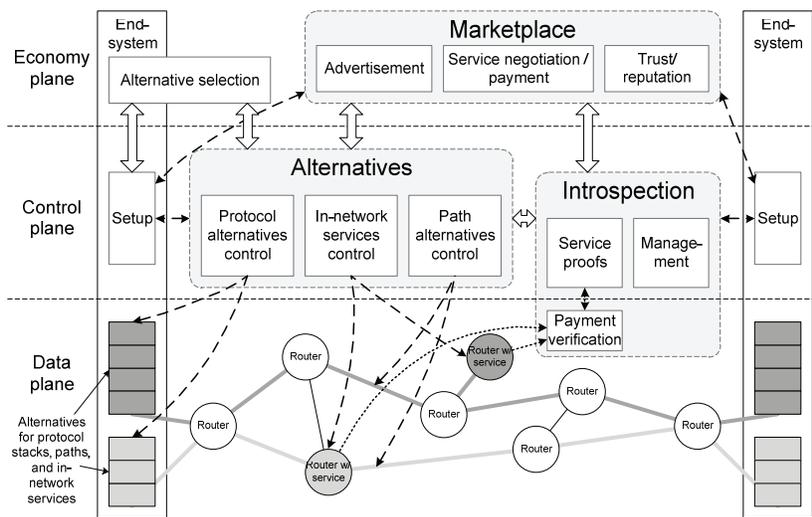


Figure 2: Overview of ChoiceNet architecture.

if at all—users must not be “stuck” when the service they receive is not consistent with their expectations. Rather, they must be able to choose a different service provider, to better meet their expectations.

- Principle 2: Vote With Your Wallet.** The underlying network infrastructure must provide building blocks so that users can financially encourage providers that offer superior (and often innovative) services, while discouraging providers that offer inferior services and fail to innovate. In other words, the “money protocols” needed for users to vote with their wallet (i.e., pay for good services) must be designed into the network. We believe that incentives and competition are crucial for the long-term health of the network—winning ideas will succeed, grow, and promote additional competition, while losing ideas fade away.
- Principle 3: Know What Happened.** Distinguishing services and providers that perform well from those that do not is crucial to enabling robust competition. In a complex system like the Internet, determining what happened (i.e., whom to blame) when an end-to-end service does not meet user expectations can be a challenging proposition because providers may be operating at different layers and in several locations along an end-to-end path. The network must provide building blocks that allow users and providers to determine, and exchange information about, the performance they experience. Such “introspection” capability of the network also enables innovative network management and monitoring tools, which themselves can evolve over time.

These principles are interdependent and mutually rely on each other. For example, if there are no other alternatives, there is no need to vote with one’s wallet, nor does it help to know that the current alternative is not a good one.

3. NETWORK ARCHITECTURE

Embracing the three principles discussed above requires new features and mechanisms not present in the current In-

ternet. Figure 2 illustrates schematically how the principles interact within a network—which we dub *ChoiceNet*—and the new features they support.

As a starting point, one needs support for alternatives, including the ability to create alternatives and select among them. To support alternatives, ChoiceNet offers new control-plane mechanisms. More importantly, ChoiceNet introduces a new *economy plane* that is responsible for supporting the types of business relationships and incentives that drive innovation and change in the real world. The economy plane supports advertisement of choices to users, as well as selection from among a set of alternatives.

Economy plane protocols enable users to negotiate desired levels of service, and pay (compensate) specific providers for services. It also includes mechanisms to help establish the identity, level of trust, and reputation of the parties involved in a business relationship.

4. USE SCENARIO

To illustrate the ability of ChoiceNet to support innovation in the network, we briefly describe one use scenario, highlighting the benefits of choice as a fundamental feature of the architecture. For this scenario, consider the selection of connection quality for video distribution.

A user may be offered different connection services for the purpose of watching streaming video. These connections may differ in their technical implementation (e.g., quality-of-service, use of caching, etc.). The user selects a service (i.e., a complete package of end-to-end connection and related services) and pays for its use. Depending on the user’s satisfaction with the video experience, they continue to use the chosen service or switch to another (i.e., vote with their wallet).

Note that users does not require to have technical expertise in judging low-level networking metrics. They simply make choices based on their overall experience. Since economic rewards are explicitly represented in the architecture, network service providers are incentivized to create innovative offerings. This approach can therefore drive continued innovation throughout the network.