ChoiceNet

Enabling new applications and business models through choice and competition

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ChoiceNet

• NSF NeTS Large project
  – Started September 2011
  – Assigned “FIA status” in 2012

• Team:
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  – North Carolina State University:
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Historical Perspective

2000 01 02 03 04 05 06 07 08 09 10

NewArch (DARPA)
SIGCOMM FDNA
NSF FIND
NSF GENI
NSF FIA
Pouzin Society
Euro–NGI
Euro–4WARD
Asia Future Internet Forum
Euro–FIRE

Early Pioneer Work
USA FIA Projects

- Named Data Networking (NDN) - UCLA (lead)
  - Content-centric, focus on “what” not “where”
- MobilityFirst – Rutgers (lead)
  - Cellular convergence (4-5B devices), interconnected vehicles
- NEBULA – Upenn (lead)
  - Reliable, high-speed core interconnecting data centers
- eXpressive Internet Arch. (XIA) – CMU (lead)
  - Rich set of communication entities as network principals
- ChoiceNet
Software Defined Networking (SDN)

- Decouples control and data planes
- Control plane SW runs on general purpose HW
  - Decouple from specific networking HW
  - Use commodity servers
- Data plane is programmable
  - Maintain, control, program from central entity
- Architecture to control entire network
Internet Economics

• Market forces have shaped services and applications at the edge

• Wealth of studies explore:
  – Economic issues arising in the Internet
  – Economic effects of existing networking technology
Network Economy Conundrum

• New architectures:
  – Focus on networking technology, not economic interactions
  – Do not provide mechanisms to introduce competition and market forces

• Existing economic models cannot be deployed in today’s Internet: No mechanisms to:
  – Discover/create contracts with any provider
  – Doing so on short time scales
ChoiceNet Goals

• Expose choices throughout network
  – Network no longer a “black box”

• Interactions between technological alternatives and economic relationships
  – Introduction of dynamic “economy plane”
  – Money as driver to overcome inertia by providers
  – Market forces can play out within the network itself

• Services are at core of ChoiceNet ("everything is a service")
  – Services provide a benefit, have a cost
  – Services are created, composed, sold, verified, etc.
ChoiceNet

• “Network architecture” with a grain of salt
  – Possibly not a complete architecture
  – Requires redesign of data and control plane
  – Aim to fit with existing and future architectures
    • Based on IPv6, but others possible
ChoiceNet Principles

- Competition drives innovation
- “Encourage alternatives”
  - Provide building blocks for different types of services
- “Know what happened”
  - Ability to evaluate services
- “Vote with your wallet”
  - Reward good services
- Principles and technology can be applied to most network architectures
  - Services and service composition
  - Economic contracts and enforcement
ChoiceNet Architecture

**Economy plane**
- Alternative selection

**Control plane**
- Setup

**Use plane**
- Services
  - Composed service offerings
  - Protocol stacks
  - In-network services
  - Paths

**Introspection**
- Marketplace
  - Service offerings and instantiation
  - Trust / reputation
  - Contracts

**Access control**
- Composition of services
- Service proofs
- Measurement

**Alternatives**
- For protocol stacks, paths, and in-network services

**Router**
- Router
- Router w/ service
Entities in ChoiceNet

- ChoiceNet enables composition of services and economic relationship
  - Economy plane: customer-provider relation
  - Use plane: client-service relation
  - Strength is ability to reflect real-world relations
Entities and Interactions

1. Register Service
2. Discover Services
3. Advertised Services
4. Request Service
5. Request Payment
6. Payment
7. Setup/Enable (if needed)
8. Service Capability
9. Service Capability
10. Service Capability
11. Invoke forwarding
12. Forwarded Pkt

Customer
Provider
Marketplace
Economy Plane
Network Service (e.g., forwarding)
Use Plane
Sender
Receiver
Composed Services

- Service author/developer creates new services
  - Composition from other service offerings
- “Integrator” acts in economy and use plane
Composed Services

• “Reseller” only acts in economy plane
  – Separation of hosting allows for such entities

• Many research questions
  – Composition of services
  – Design of enforcement across providers
Provider Ecosystem

• Incentives for actors to participate?
  – Everyone can be rewarded
    (authors, host, integrator, verifier)
  – Good and innovative services get rewarded

• Payments among actors to sustain viability
  – Economy plane distributes value (e.g., money)

• Same commercial entities as today?
  – Similar providers, but also finer-grained providers
  – New providers for composition and verification
ChoiceNet Technologies (in progress)

• Economy plane
  – Methods for describing, composing, and instantiating services
  – Marketplaces for connecting customers and providers (e.g., search for services)
  – IDs associated with entities

• Use plane
  – Verification of economy plane contracts in use plane (e.g., capabilities with delegation)
  – Measurement services to verify offerings
Use Cases Enabled by ChoiceNet

- ChoiceNet / economy plane enables new business models in the Internet
  - Highly dynamic economic relationship possible
  - All entities get rewarded

- Examples
  - Movie streaming
  - Reading NYT in coffee shop (long-term contracts)
  - Reading NYT in coffee shop (short-term contracts)
  - Customers as providers
Movie Streaming Example (1)

• Choices for movie streaming
  – Technical choices:
    • Different connections, transport, caching, etc.
  – Economic choices:
    • Pay more or less for a particular video experience
  – Technical choices are packaged and sold as experiences

• End-user interactions with ChoiceNet
  – Select, pay for, and expect a certain experience

• Opportunities for developers
  – Novel solutions composed from other services and offered in marketplace
  – Developers without infrastructure can innovate
Movie Streaming Example (2)

- User pays video service provider (e.g., Netflix)
Movie Streaming Example (3)

• Developer provides cached video service
Movie Streaming Example (4)

- Developer provides services without infrastructure

*Diagram showing service providers and developers.*
NYT Example (long-term contracts)

- Alice purchases “access anywhere” service from NYT
- NYT contracts with CDN to distribute its content “anywhere”
- CDN contracts with:
  - Access providers in popular locations (Starbucks)
  - Transit providers to carry content
- ChoiceNet provides credentials that Alice (or her laptop/browser) can present to the WiFi network at Starbucks to access CDN server (only), and to CDN server to access NYT
NYT Example
(fully unbundled, ephemeral contracts)

• Alice (or her ChoiceNet agent) pays for 1-time, limited use of the Wi-Fi network in Starbucks
  – Includes access to marketplace(s)

• Alice searches marketplace for “paths to NYT content service”, receives offers, buys one(+)

• Alice uses path to connect to NYT service, purchases access to current issue, downloads NYT content
Customers as Providers

• Line between providers and customers blurs
  – Everybody can offer services
  – Services can be based on purchased services

• Example
  – Resell network access that I buy from provider
  – Similar to small-scale Mobile Virtual Network Operator (MVNO)

• Number of provider choices can be large
  – Large-scale competition and innovation
Conclusion

• ChoiceNet makes economic relationships explicit through the economy plane
  – Everything is a service
  – Choices drive competition and innovation

• Democratization of network operation
  – Entities without infrastructure can participate

• ChoiceNet fits with any network architecture