

ChoiceNet Tutorial

Part II – Competition in ChoiceNet

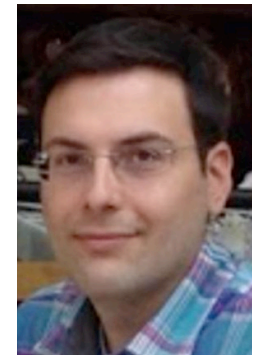
GEC 21

Welcome!

- Agenda
 - Part I (“Introduction”): (1:30 – 3:00)
 - **Overview** of ChoiceNet Project
 - **Implementation** on GENI
 - **Hands-on use**
 - Part II (“Advanced”): (3:30 – 5:00)
 - **Economics** of ChoiceNet
 - **Building a service** on ChoiceNet
 - **Hands-on use**

ChoiceNet People at Tutorial

- **Tilman Wolf, UMass**
- **Jim Griffioen, UKY**
- **Hussam Nasir, UKY**
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- **Onur Ascigil, UKY**
- **Thiago Teixeira, UMass**
- **Charles Carpenter, UKY**
- **Abhishek Dwaraki, UMass**



Hands-On Exercise

Hands-On Exercise

- Instructions:
 - <http://groups.geni.net/geni/wiki/GEC21Agenda/ChoiceNet>
 - Both source-routed and SDN-based services
- Please complete the following steps:
 1. Login and Pre-setup
 2. Configure and Install ChoiceNet Software
 - Step 3 takes a while – we'll continue with the presentation while we wait

ChoiceNet

- **“Economy plane”** for the Internet
 - Users can **choose network services**
 - **Fine-grain contracts** for each service
 - **Competition** among providers to drive innovation
- Two implementations of services in ChoiceNet
 - **Source-routed** forwarding and path service
 - **SDN-based** forwarding and path service
- Network services tied to PayPal transactions

Economic Behavior in ChoiceNet

- End-users/applications have choice
 - End-users **pay for service**
- What happens to providers?
 - Can providers still **make money**?
- Does competition really lead to **innovation**?
 - Are providers incentivized to innovate?
- Economic model to **understand market**
 - Very simple metrics: price, quality

Market Interactions

- Customer has a **preference**



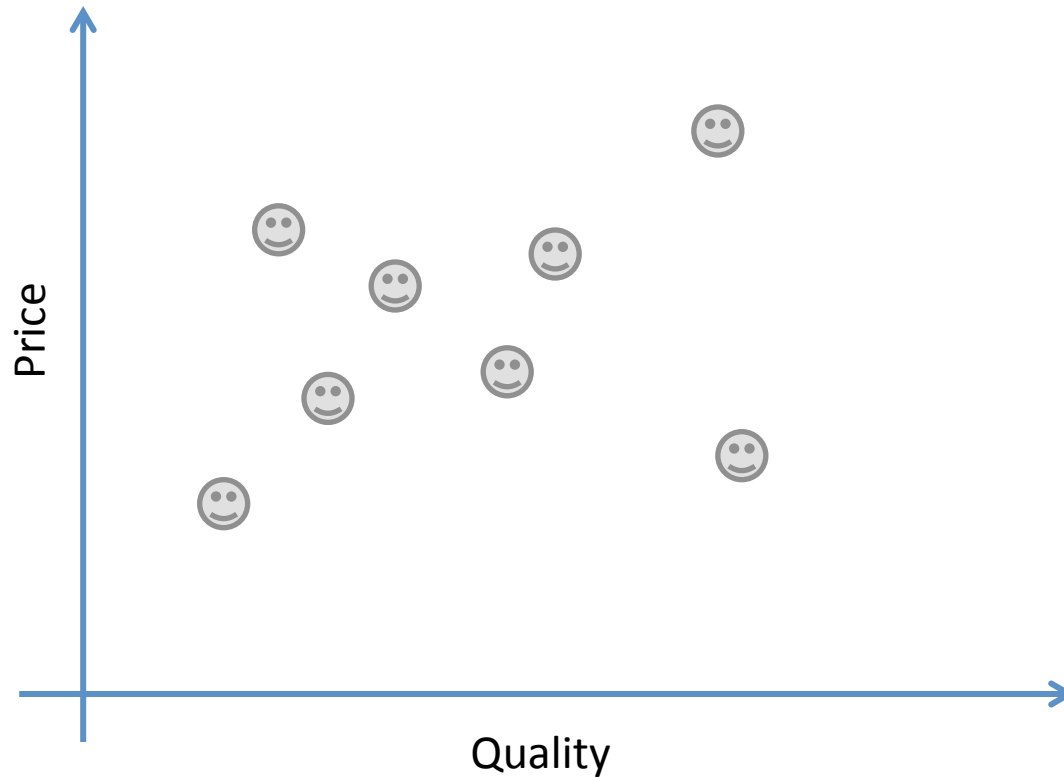
Market Interactions

- Market consists of **many customers**



Market Interactions

- Providers do **not** know preferences a priori



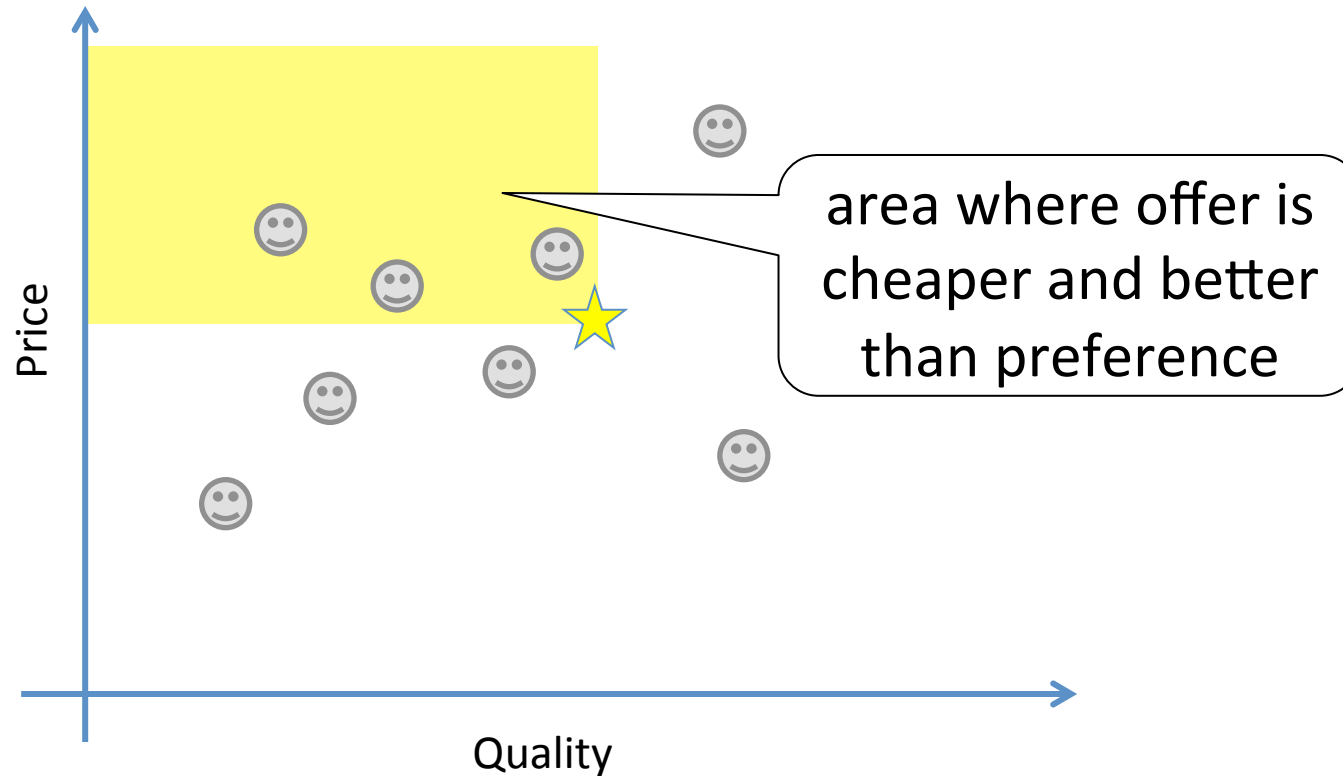
Market Interactions

- Providers **offers service** in marketplace



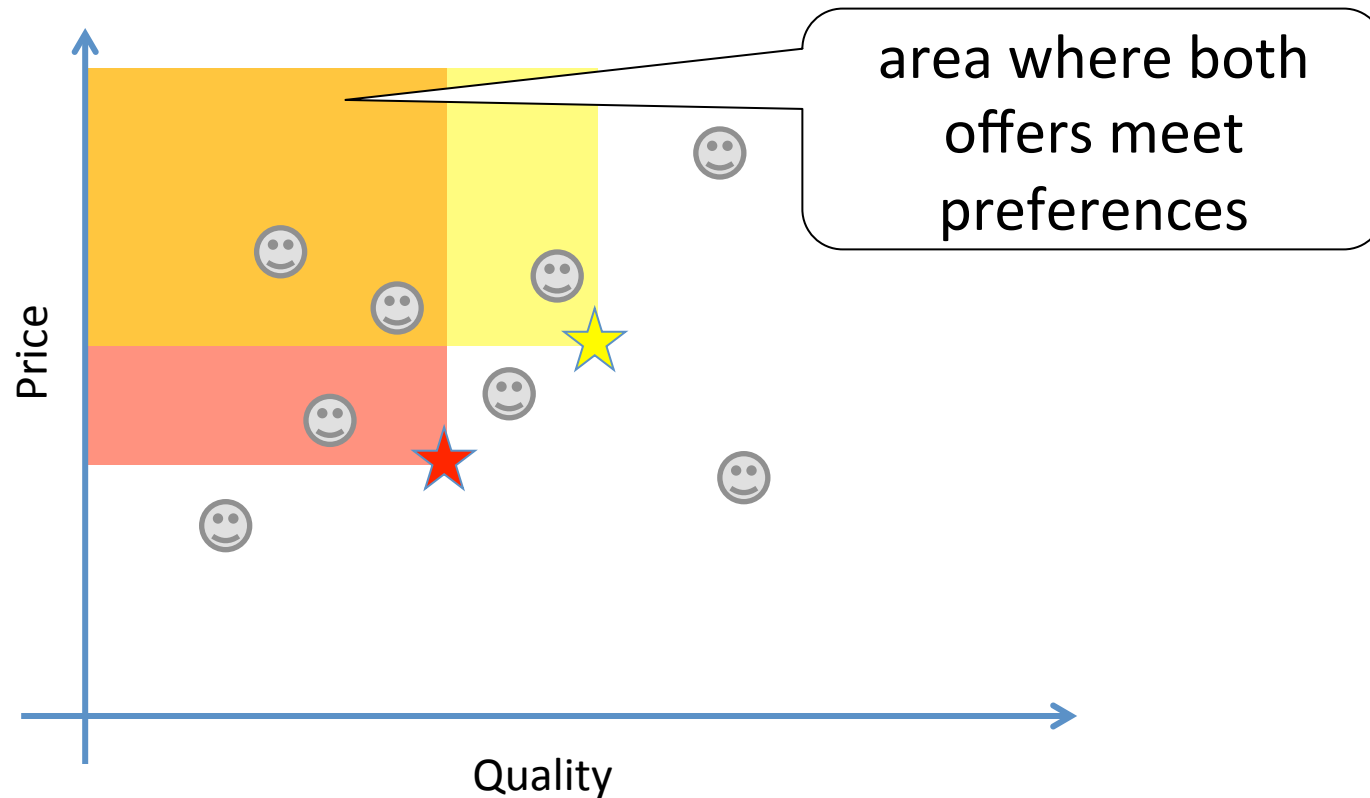
Market Interactions

- Offer meets preference of **some customers**



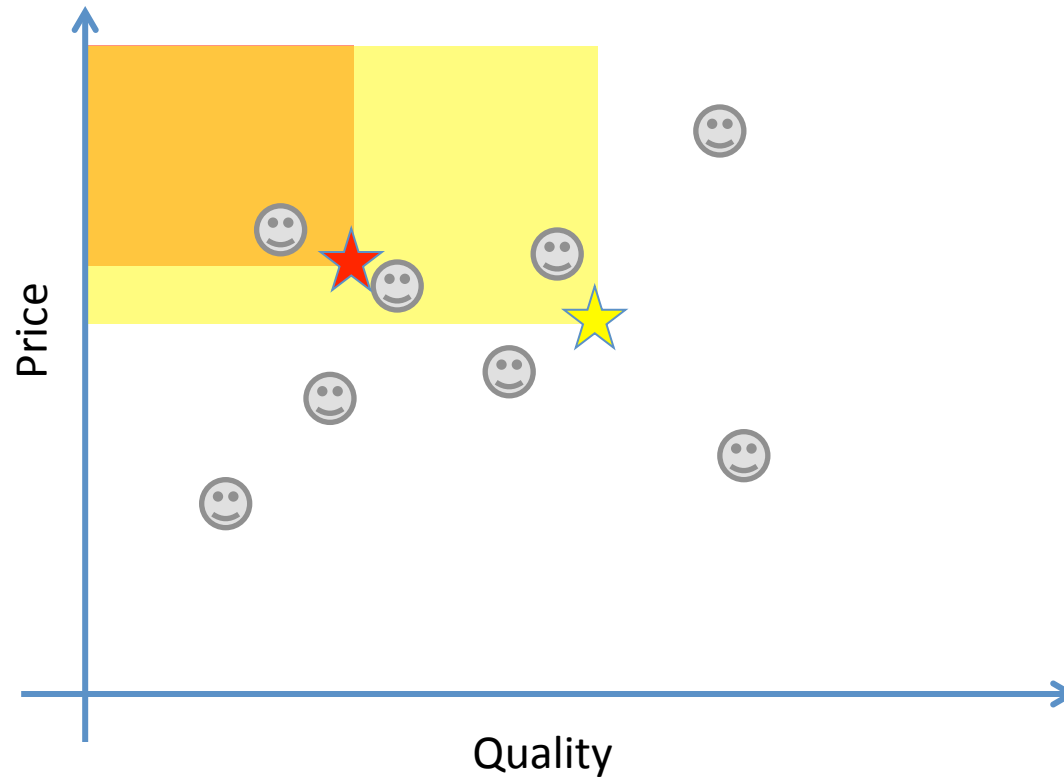
Market Interactions

- **Competing offer** (same or different provider)



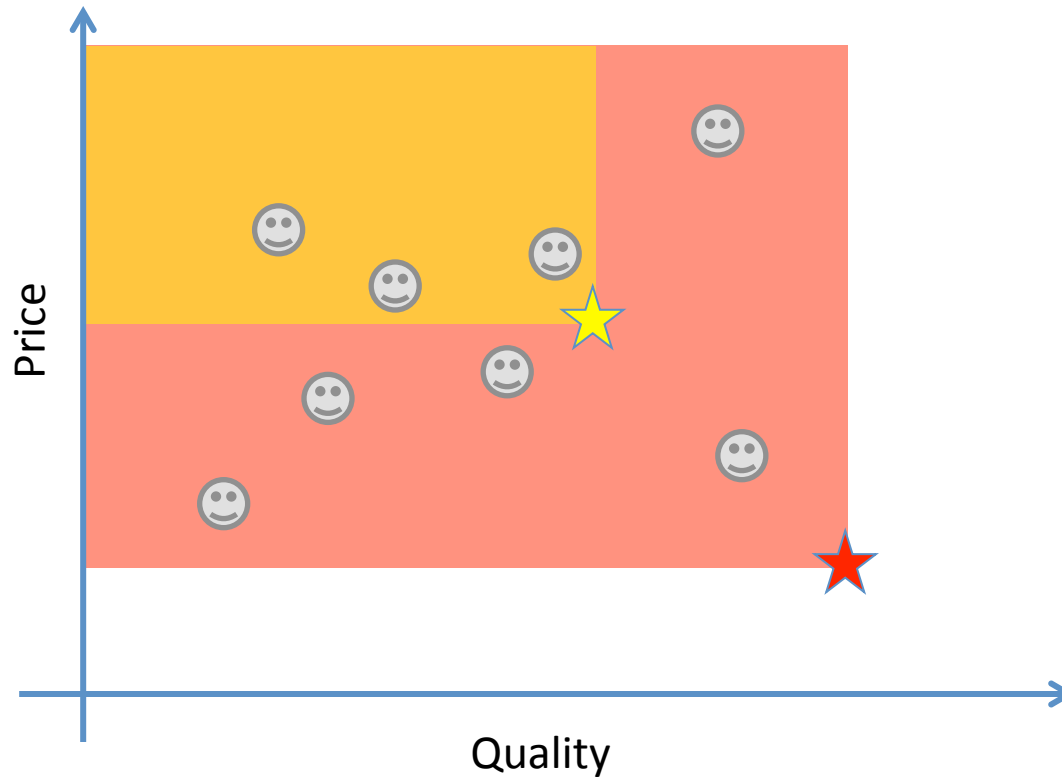
Market Interactions

- Red offer **strictly worse** than yellow



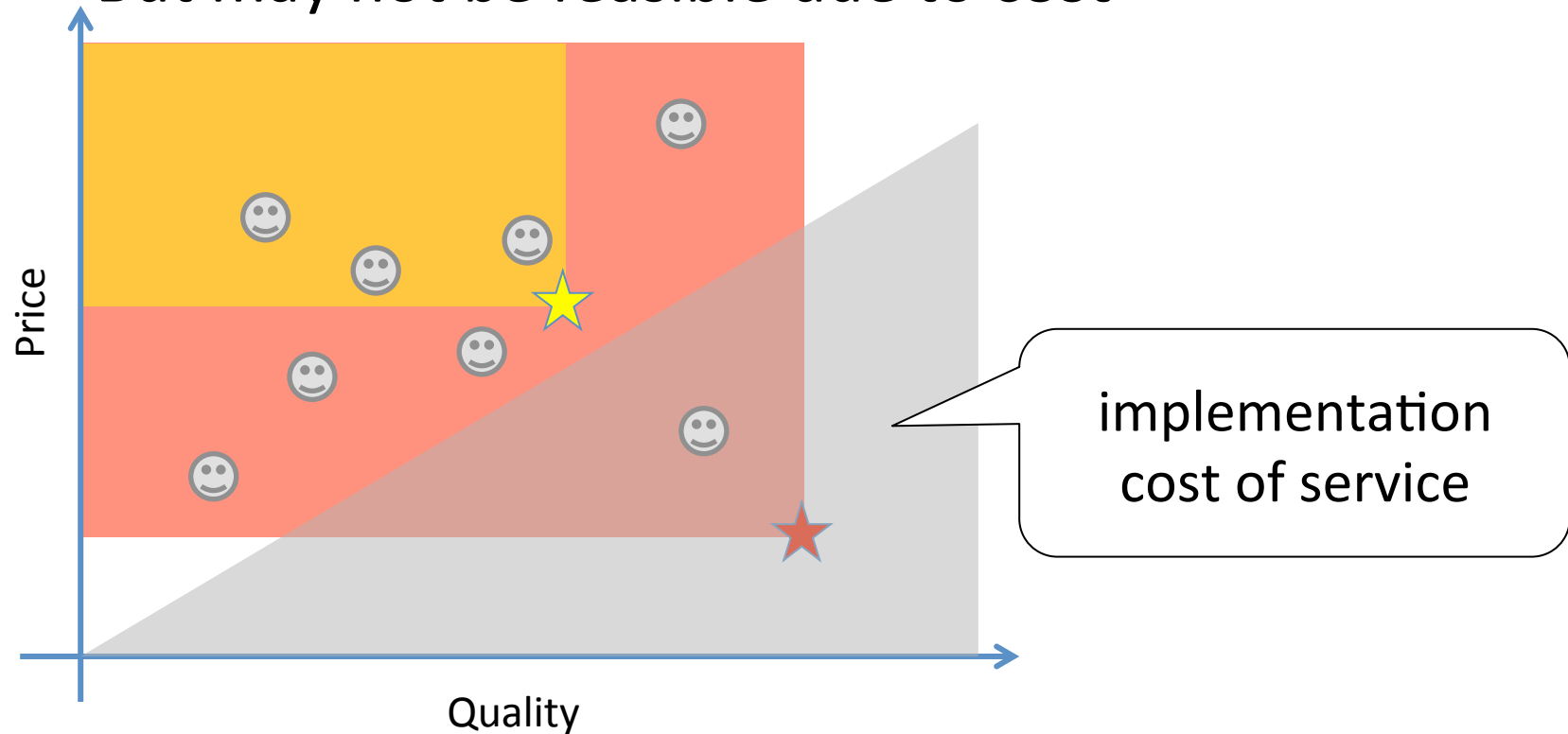
Market Interactions

- Red offer **strictly better** than yellow



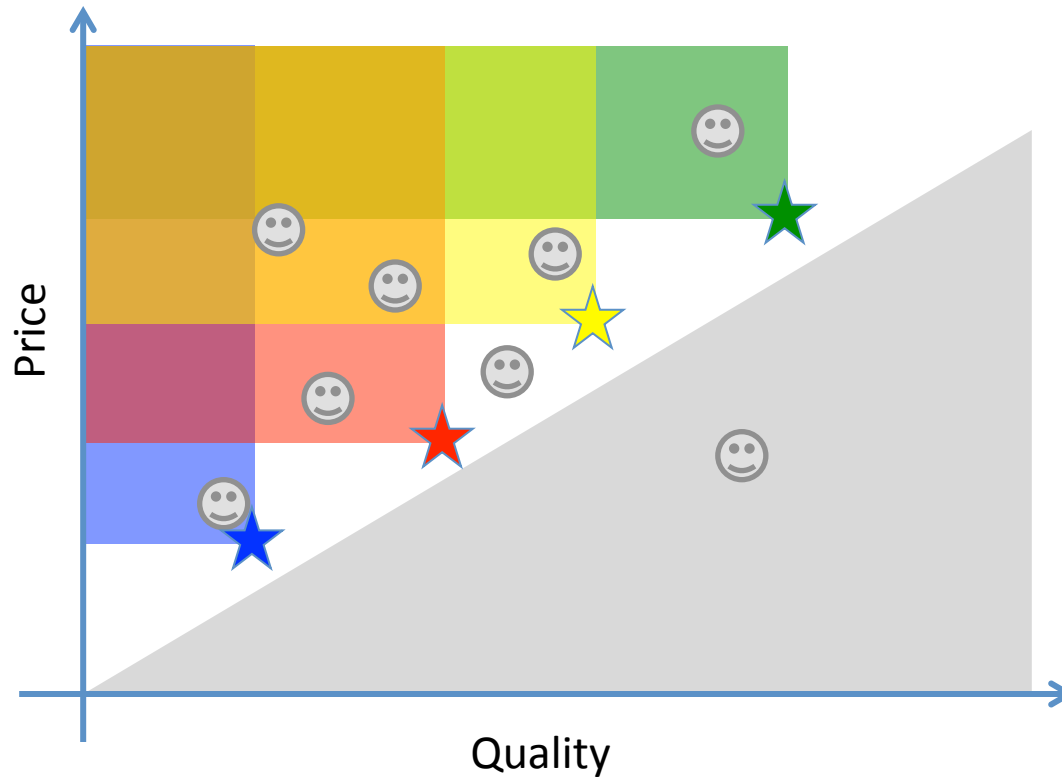
Market Interactions

- Red offer **strictly better** than yellow
 - But may not be feasible due to **cost**



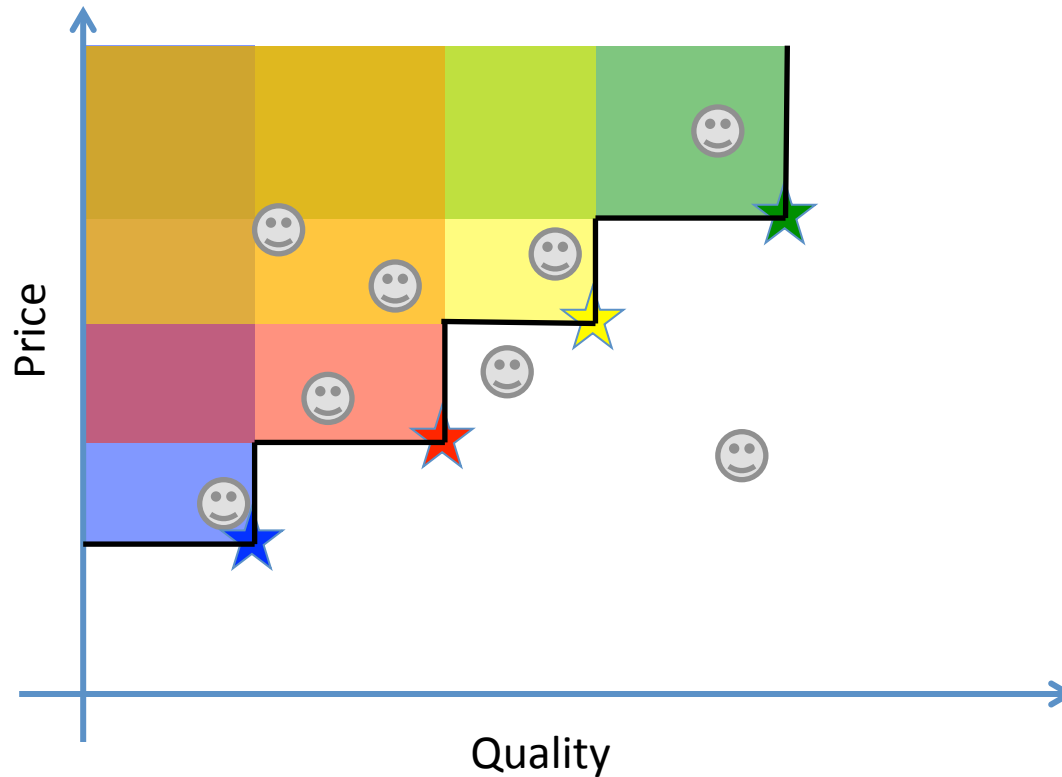
Market Interactions

- Offers will be along **cost constraints**



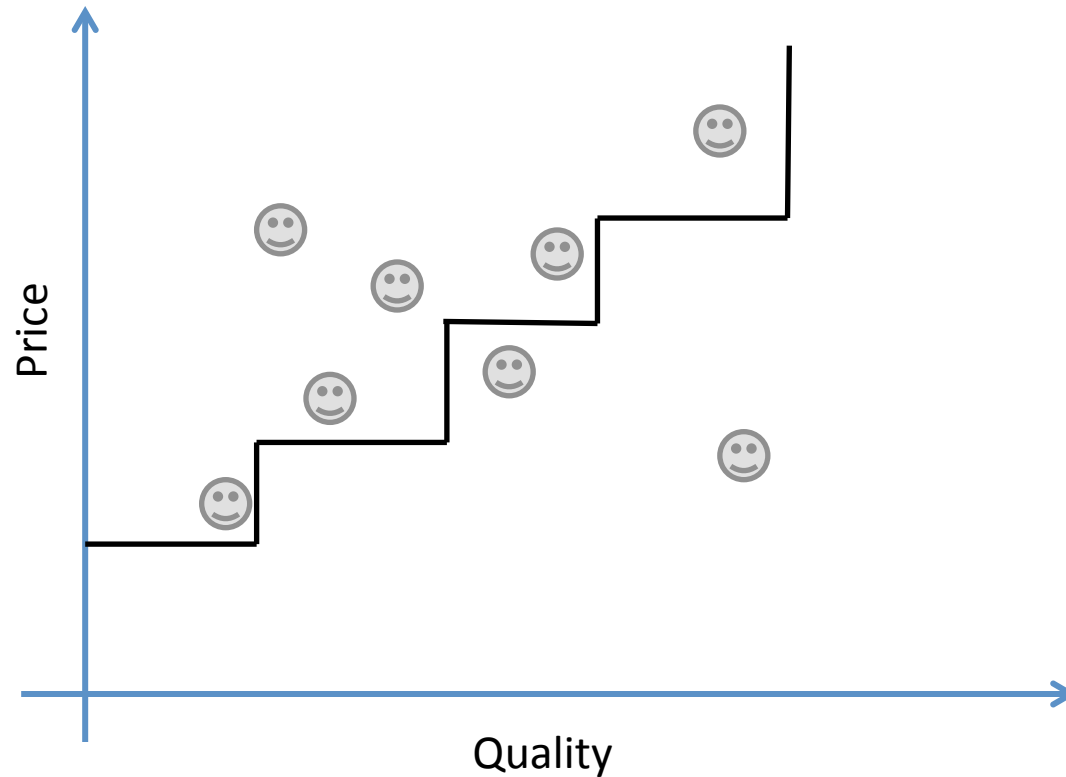
Market Interactions

- Offered summarized in **Pareto front**



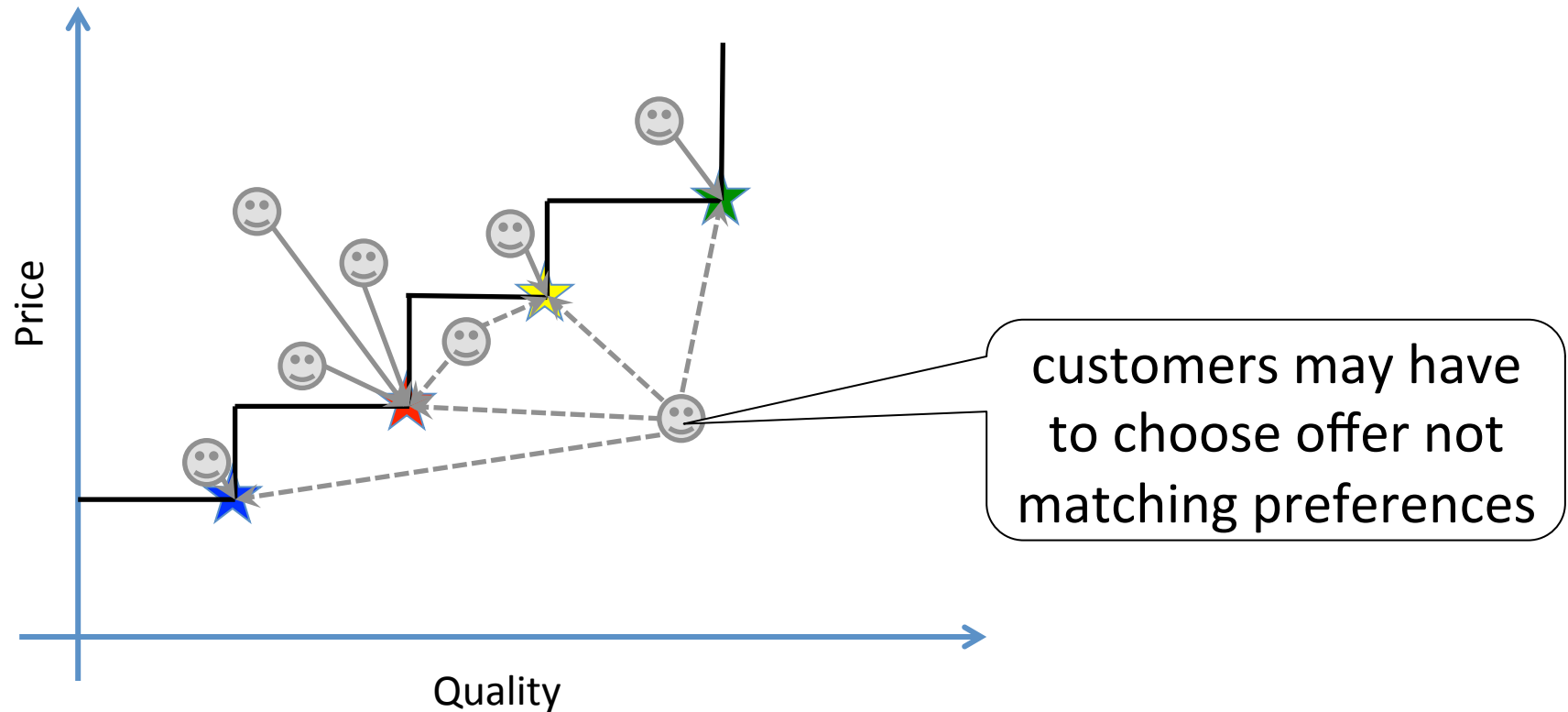
Market Interactions

- Offered summarized in **Pareto front**



Market Interactions

- Customers choose offer “**close**” to preference

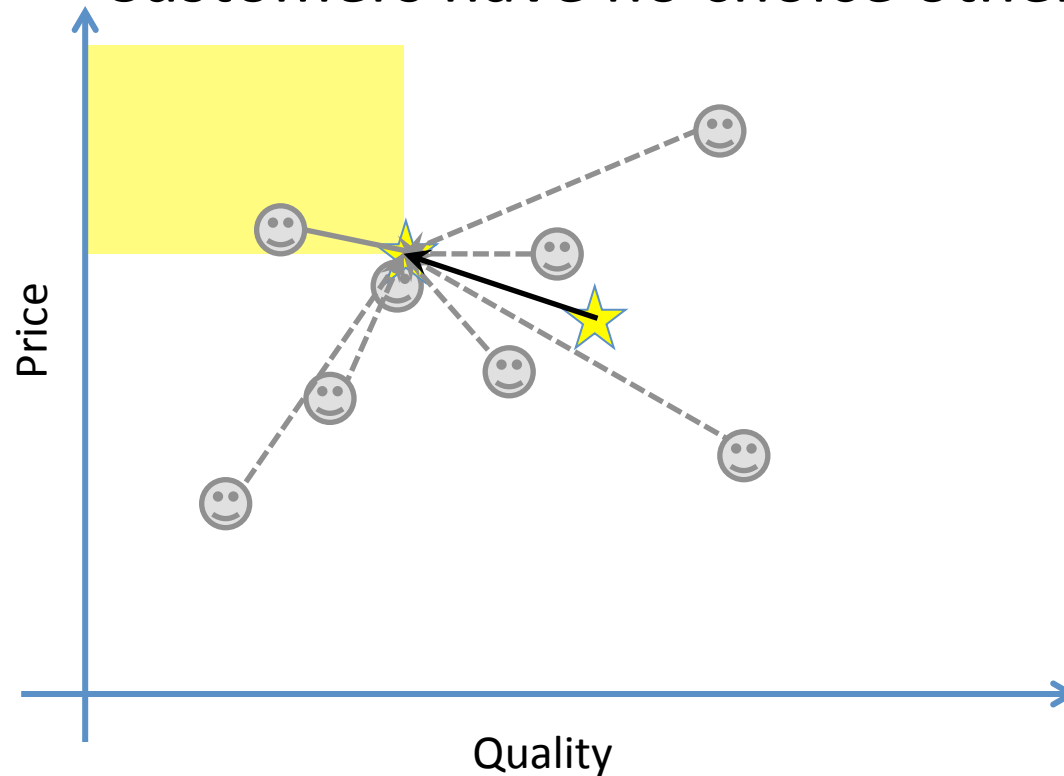


Simulations

- We want to track market over time
- **Agent-based simulation**
 - **Iterative** process
 - Provider places offer in market
 - Customers choose one offer (or none)
 - Providers find out what offer was purchased
 - Providers update their offer
 - **Metrics**
 - Price
 - Quality
 - Profits

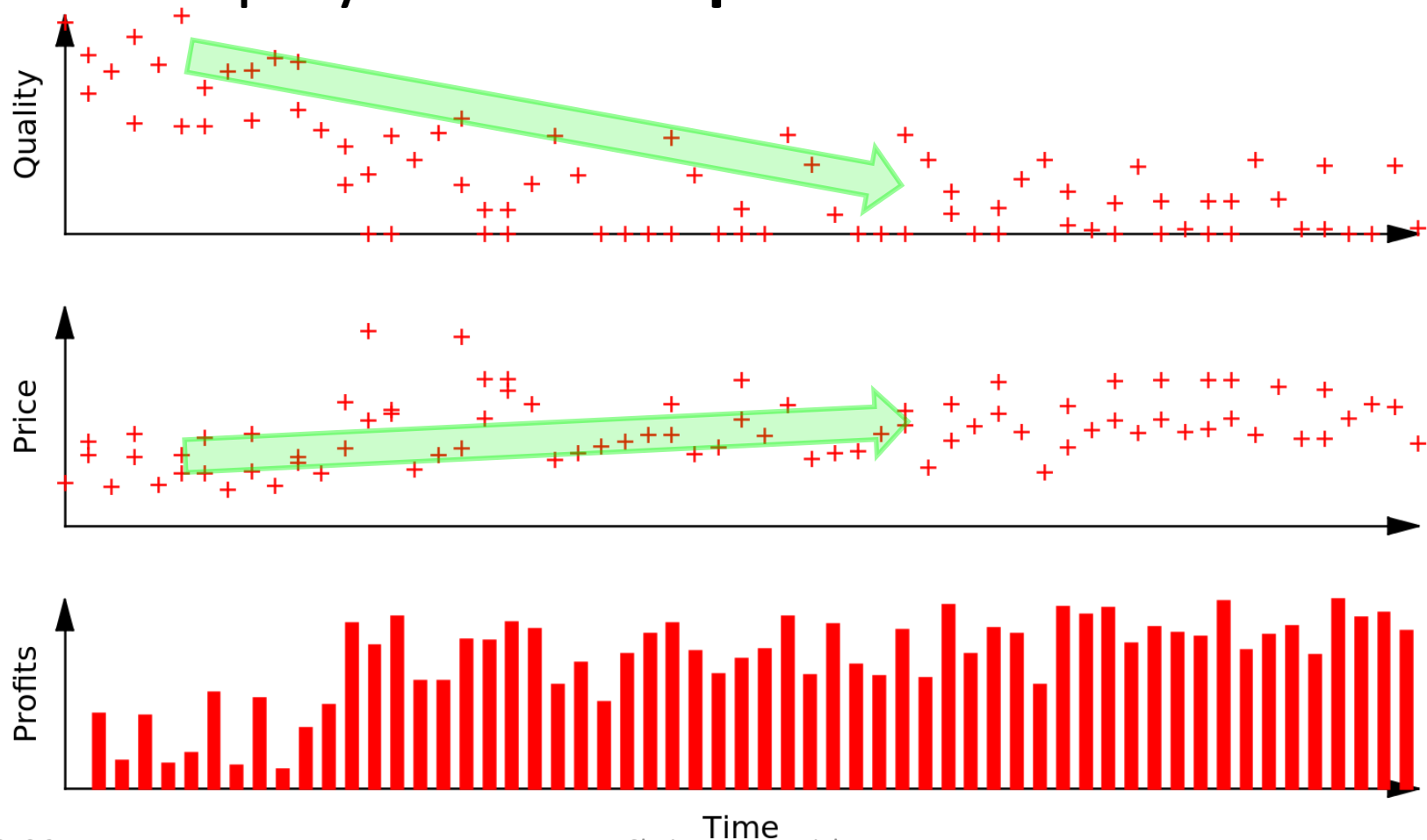
Provider Strategies: Monopoly

- Provider can **increase price / lower quality**
 - Customers have no choice other than to drop out



Simulation Results: Monopoly

- Monopoly enables **exploitation** of customers

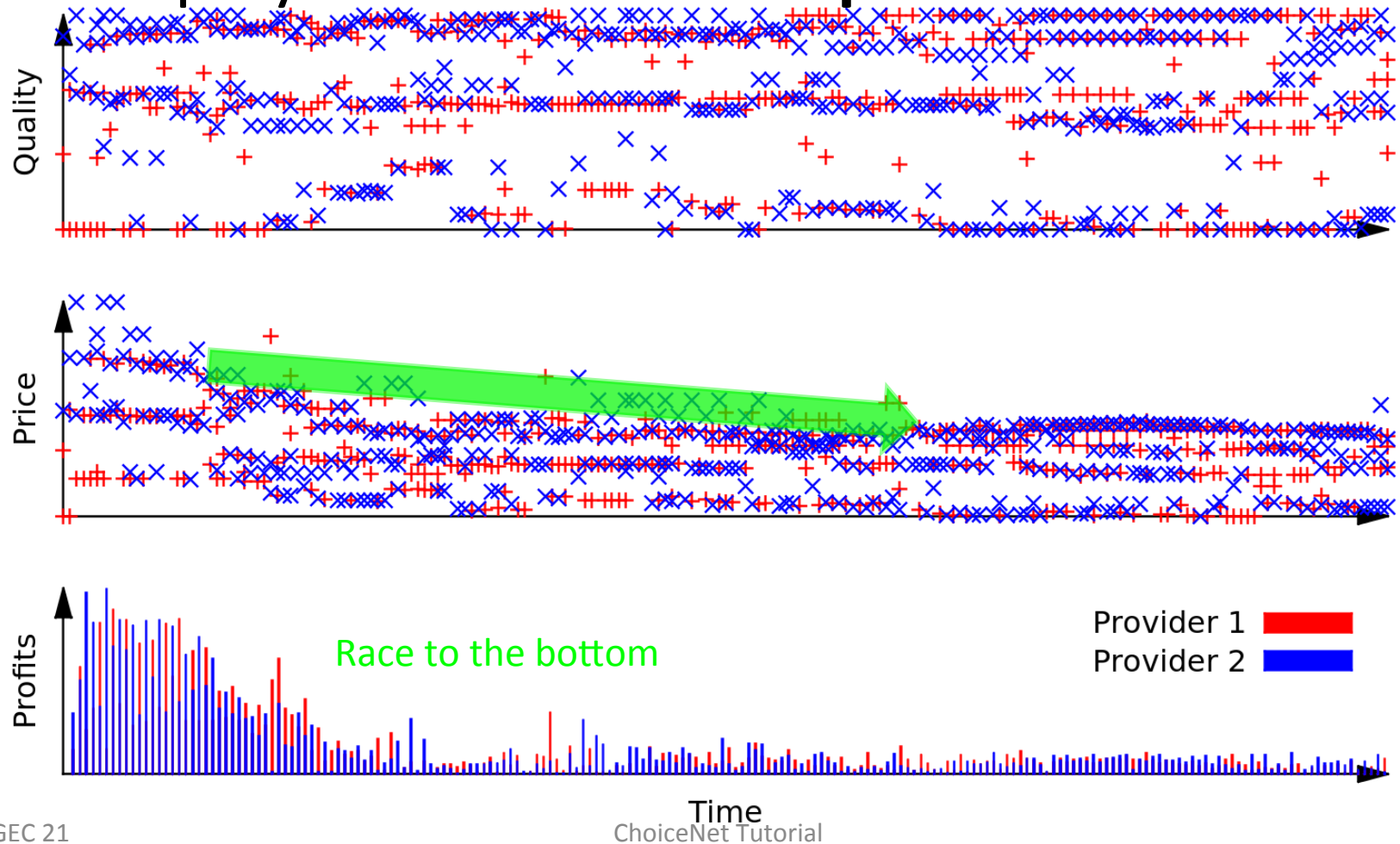


Provider Strategies

- Duopoly
 - **Second provider** can compete on price or quality
- Competition
 - Provider may have **multiple offers** in market
- What do we expect?
 - Multiple, competing offers close to cost
 - Profits drop due to “**race to the bottom**”

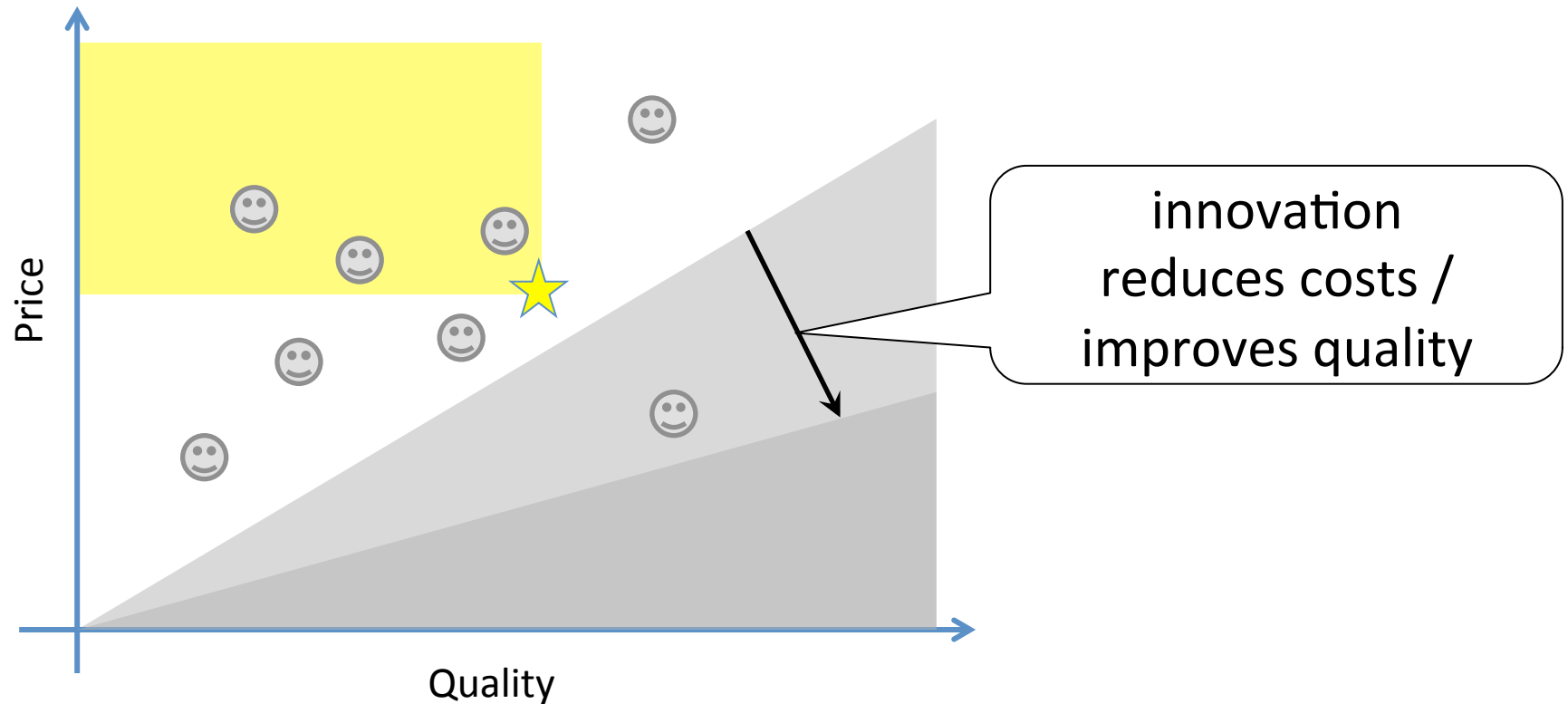
Simulation Results: Duopoly

- Duopoly leads to **reduced profits**



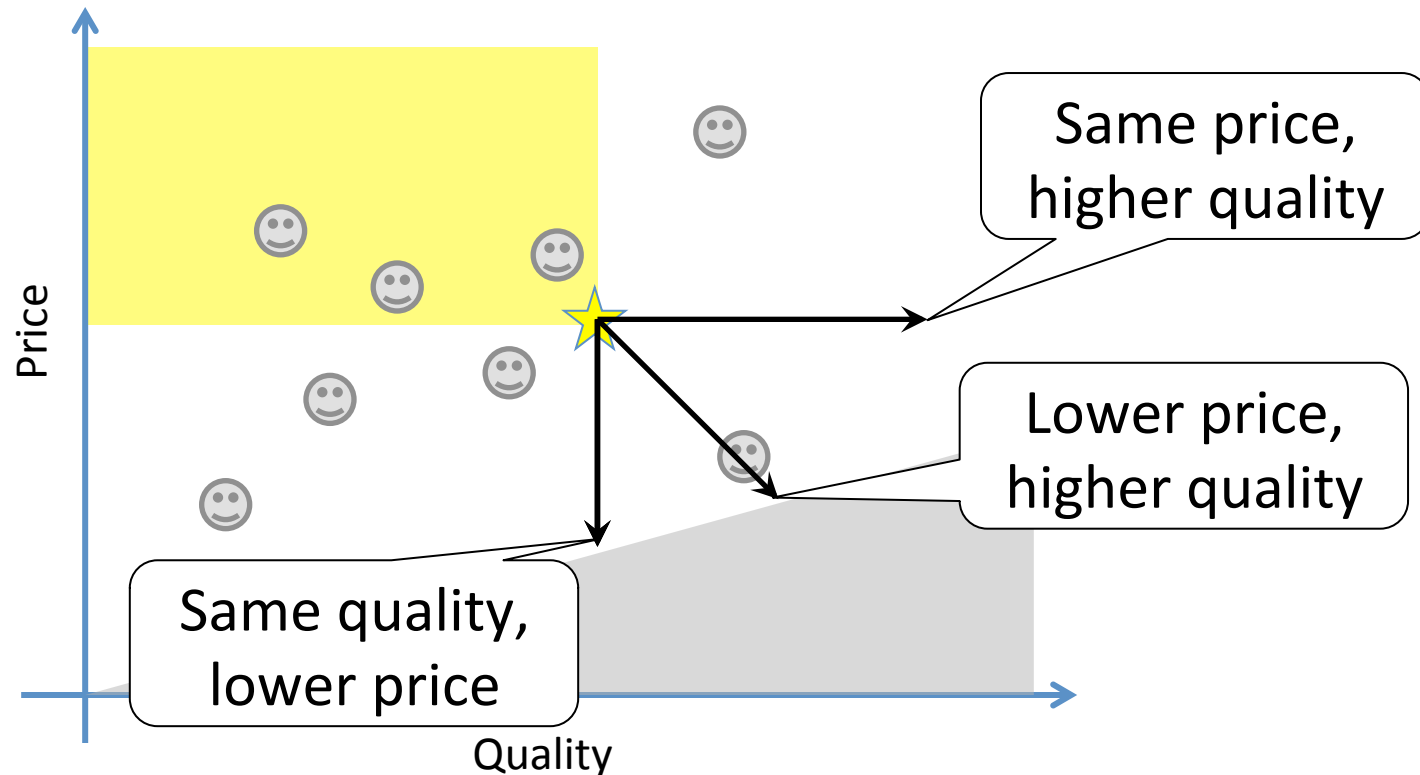
Provider Strategies

- **Innovation** enables new offers, profits:



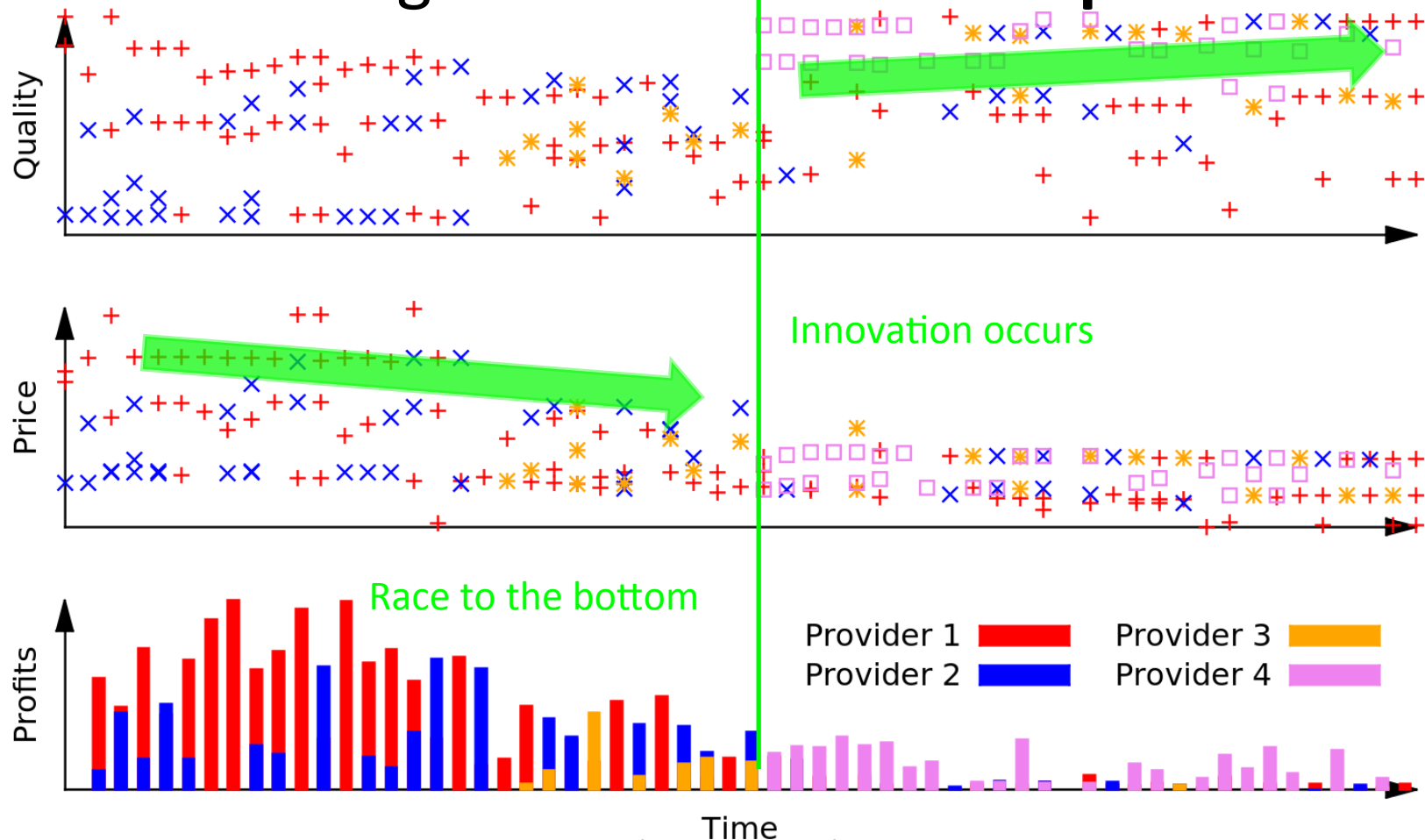
Provider Strategies

- Provider can **improve cost** and/or **quality**:



Simulation Results: Oligopoly

- Innovation gives Provider 4 more profits



ChoiceNet Economics Summary

- **Competition is good** for consumers
 - Lower cost
 - Higher quality
 - More offerings close to preference
- Providers need to work harder
 - Profits go to **innovative providers**
 - Dynamics require adaptation of offers
- Real world much **more complex**
 - Re-sale of services, changing preferences, etc.

Building a Service

Implementing Your Own New and Innovative Services

- Hidden Part
 - Code that implements your service, may communicate with other pieces of your service somehow.
 - Communication within your service is not required to adhere to ChoiceNet's protocols or make use of the economy plane
- Exposed Part
 - Offers a service via the marketplace/economy plane
 - Adheres to ChoiceNet's protocols and customer/provider interaction models.
 - May consist of several pieces playing one or more roles in the ChoiceNet architecture (e.g., data plane service, economic plane provider, economic plane customer, marketplace advertiser, reseller, broker, etc.)

Observations

1. Entities in ChoiceNet often play multiple roles (e.g., provider and customer, provider and marketplace advertiser).
2. All interactions require some form of consideration (payment)
3. Operations may follow a request/response model, or may be a composed set of requests (generating a response as output)
4. A unified protocol design can be used when communicating with any ChoiceNet entity

ChoiceNet's Unified Protocol

- Supports 2 modes of operation:
 - **“Client/Server” Model:** Client sends a request message to the service, which in turn sends back a response message.
 - **“Pass Through” Model:** service passes packets to the next service in a composition of services.
- ChoiceNet defines two packet formats: one for service requests, one for service results (response/output).
- ChoiceNet defines the fields that comprise the packet, but do not specify the format the data within those fields. The format for each of the fields is service-specific. Libraries are provided that provide common formats for these fields.
- Use the ChoiceNet protocol when:
 - Registering a service with a marketplace advertiser
 - Searching for services in the marketplace
 - Requesting and paying for services
 - Using services in the data plan
 - Communicating between a broker and the services it is a broker for
 - Etc – all communication between ChoiceNet entities (Exposed parts)

ChoiceNet Request Message

- Each field in the ChoiceNet packet consists of a length and value.
- ChoiceNet request messages consist of the following fields:
 - *Service Identifier*: A globally unique name for the service.
 - *Arguments*: Service Specific Arguments.
 - E.g. Location of the service, type, etc.
 - *Consideration*: Payment for the service.
 - E.g. **Token (Proof-of-Purchase)**, PayPal payment, etc.
 - *Output*: [Optional] for pass-through services.
 - E.g. *Accountability (i.e. proof of service)*.

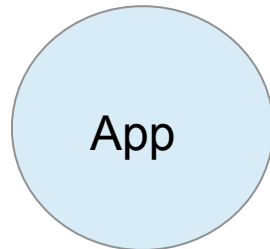
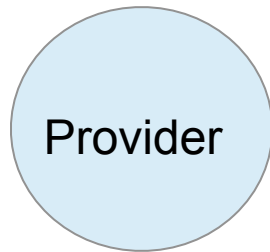
ChoiceNet Result Message

- Each field in the ChoiceNet packet consists of a length and value.
- ChoiceNet result (response/output) messages consist of the following fields:
 - *Service Identifier*: Globally unique name for the service.
 - *Output*: Encodes the output of the service.
 - *E.g. Set of paths, transcoded video, etc.*
 - *Receipt*: Service provides a token as a receipt, which is used as a Proof-of-purchase by the customers in the use-plane.
 - *Accountability*: Cryptographic proof that the service is performed.

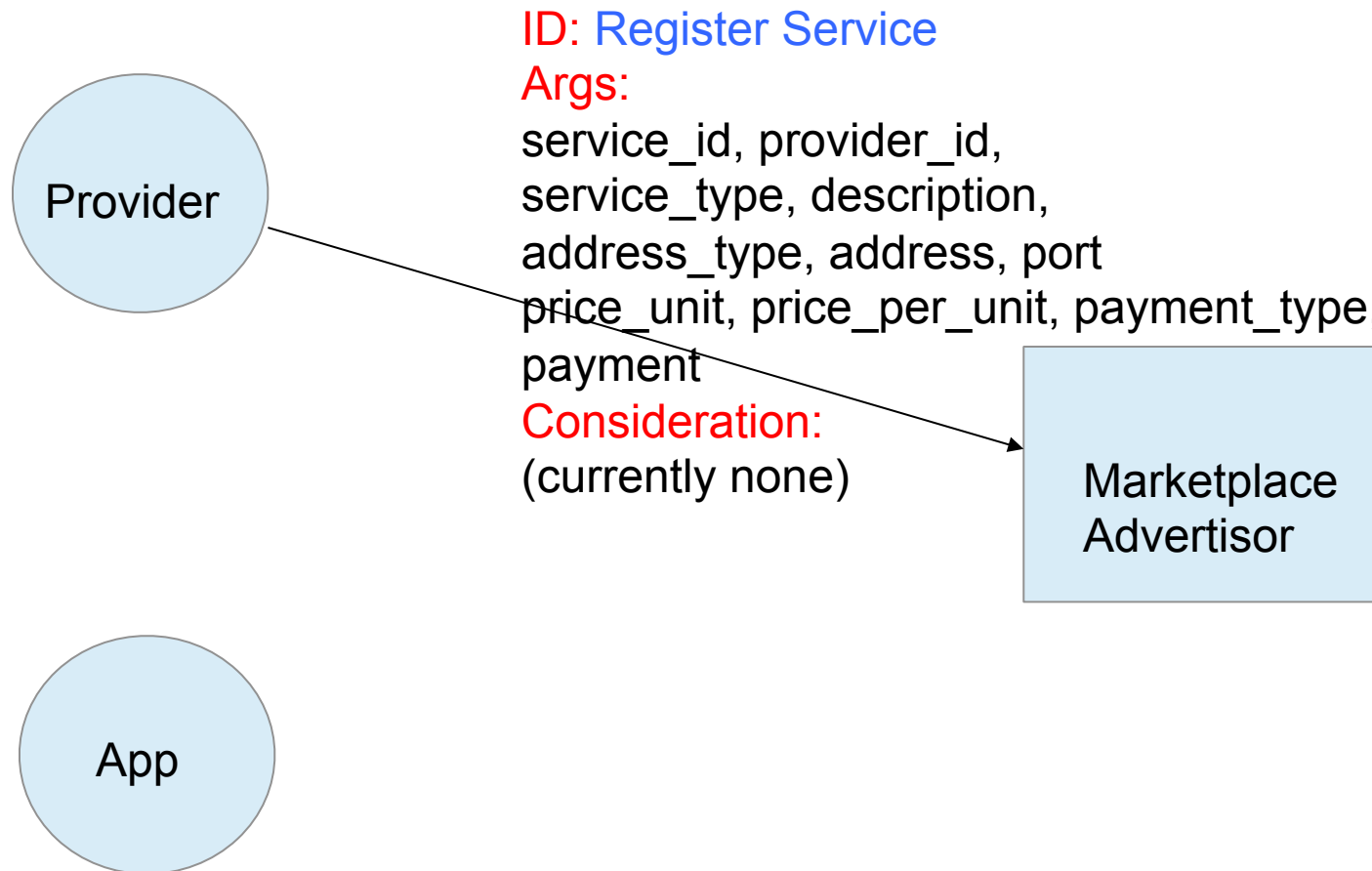
ChoiceNet Protocol Libraries

- To write a ChoiceNet service, one needs to link against the appropriate ChoiceNet library to assist with ChoiceNet communication.
- ChoiceNet libraries exist to:
 - Send ChoiceNet messages:
 - `sendrequest(service_id, arguments, consideration, output)`
 - `sendresponse(service_id, output, receipt)`
 - Receive ChoiceNet messages:
 - `recieverrequest(service_id, arguments, consideration, output)`
 - `receiverresponse(service_id, output, receipt)`
- Libraries also exist to fill/read fields in the packets depending on the role the entity is playing.

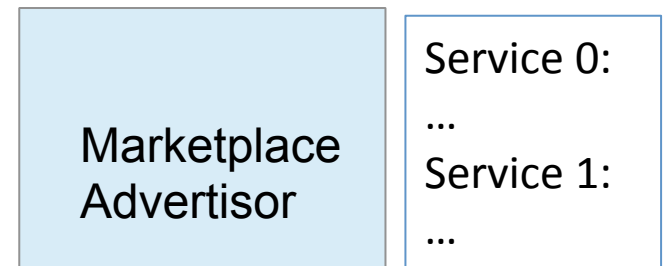
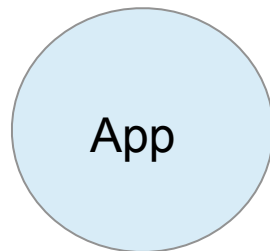
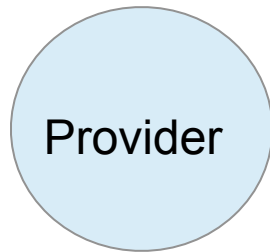
Talking to MarketPlace Advertisers



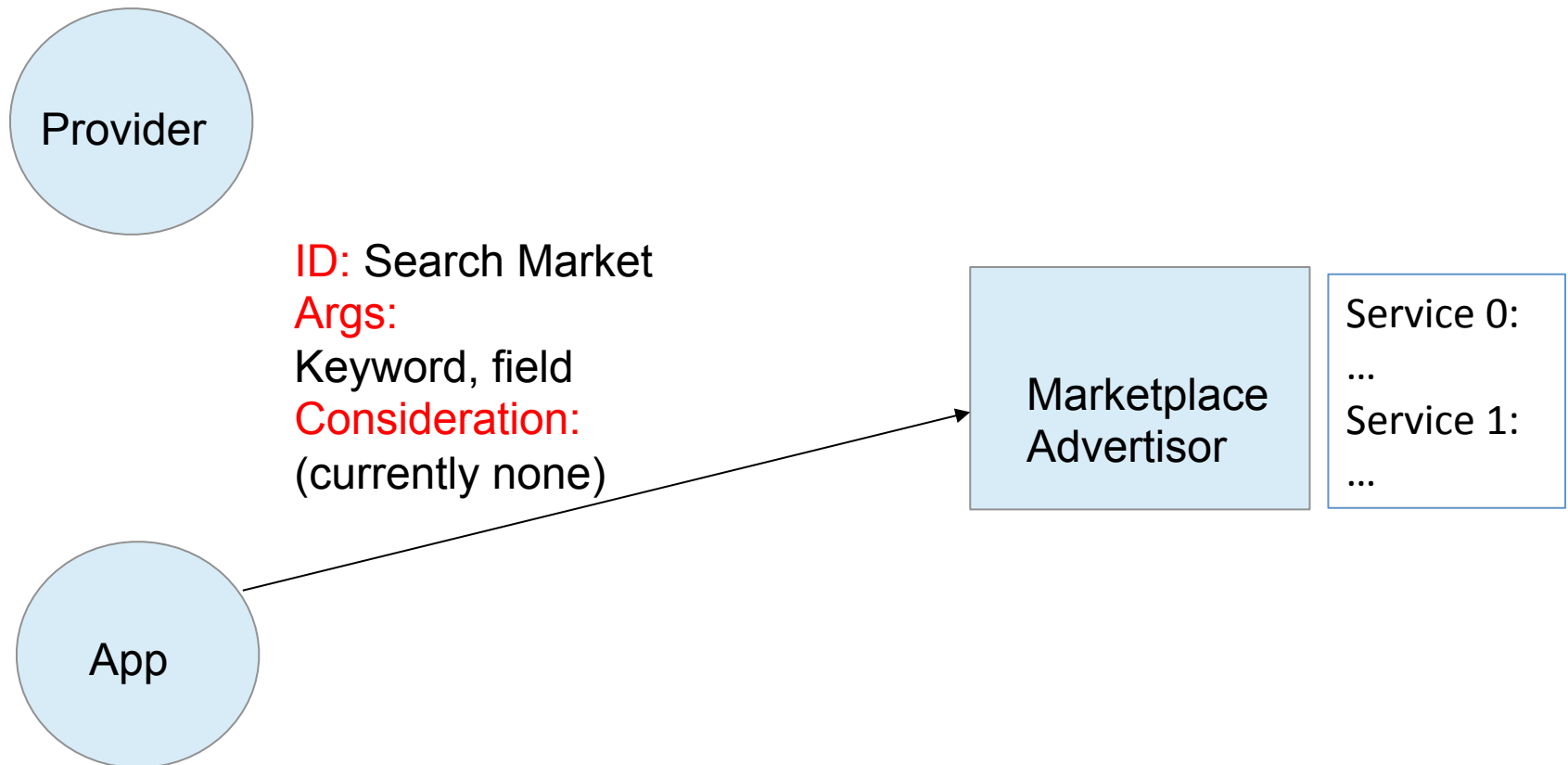
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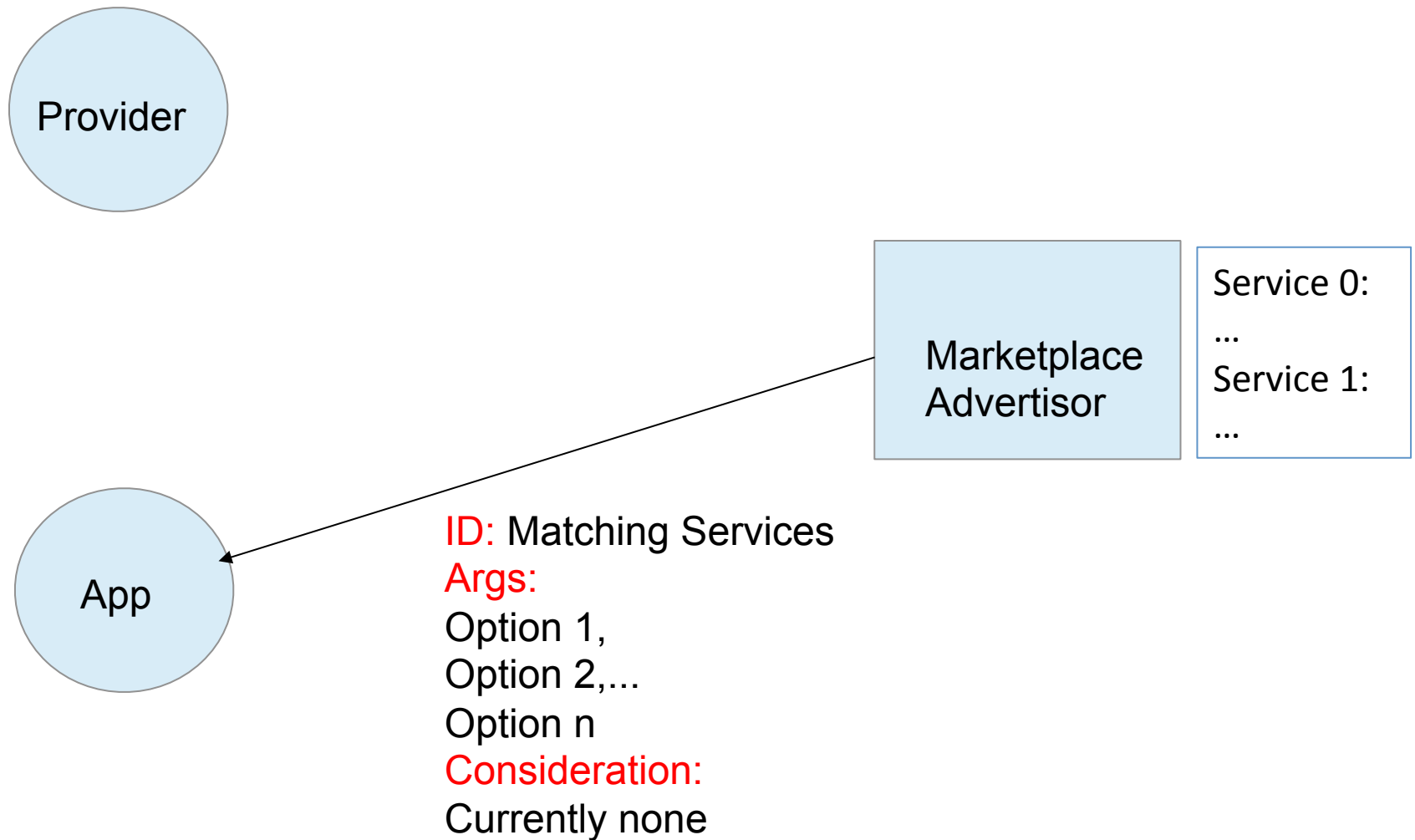
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Talking to MarketPlace Advertisers



Talking to MarketPlace Advertisers



Hands-On Exercise

Hands-On Exercise

- Instructions:
 - <http://groups.geni.net/geni/wiki/GEC21Agenda/ChoiceNet>
 - Both source-routed and SDN-based services
- Complete remaining steps (if not done yet):
 3. Interacting with ChoiceNet Apps
 4. Run Apps in ChoiceNet (PART 1)
 5. Run Apps in ChoiceNet (PART 2)
- Optional: play with your slice, break things, ...
 - E.g., change iperf parameters
 - Let us know what you discover

Acknowledgements

- All ChoiceNet collaborators:
 - **Ken Calvert**, UKY
 - **Rudra Dutta**, NC State
 - **George Rouskas**, NC State
 - **Ilya Baldine**, RENCi
 - **Anna Nagurney**, UMass
- Economic simulation:
 - **Luis Andres Marentes Cubillos**, Univ. de los Andes
- National Science Foundation
- GENI Project Office

Thank you!

More information about ChoiceNet:

<http://choicenet.info>