Policy-Based Service Selection

Helge Janicke and Monika Solanki
(heljanic@dmu.ac.uk / monika@doc.ic.ac.uk)

STRL, De Montfort University / DOC, Imperial College

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Outline

1. Motivation

2. Service Architecture

3. Policy & Preferences

4. Example

5. Conclusion

Motivation

The *Why Policy-Based?* Question

- Quality of Service (QoS) is an ill-defined term.
- Service Level Agreements (SLA) define the QoS that a provider is expected to deliver.
- SLAs are legally binding, however it may or may not be feasible to take action.
- Some providers may guarantee less, but in fact provide "more" (or vice versa).
- Static SLA negotiation may not be useful if the system is characterised by: *uncertainty*, *failure* and frequent *re-configuration*.
- Instead: Best effort approach based on *dynamic* QoS attributes. QoS becomes *subjective*.
- How can we support this subjective QoS?

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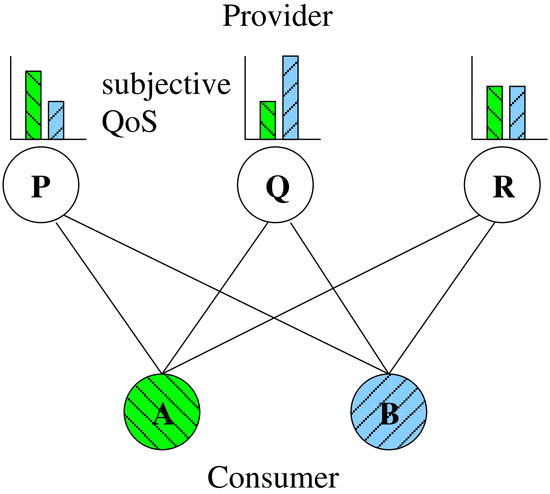
Subjective QoS is based on experiences.



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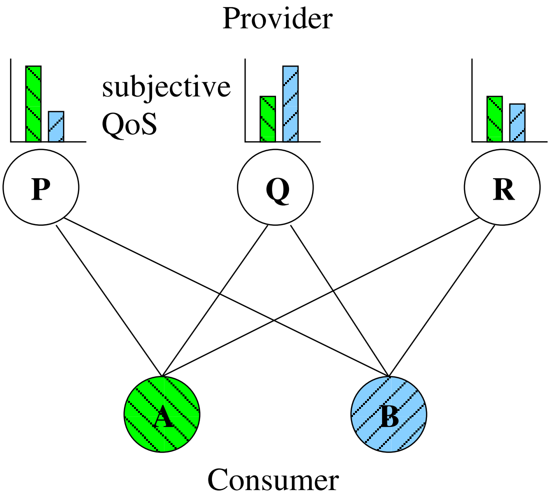

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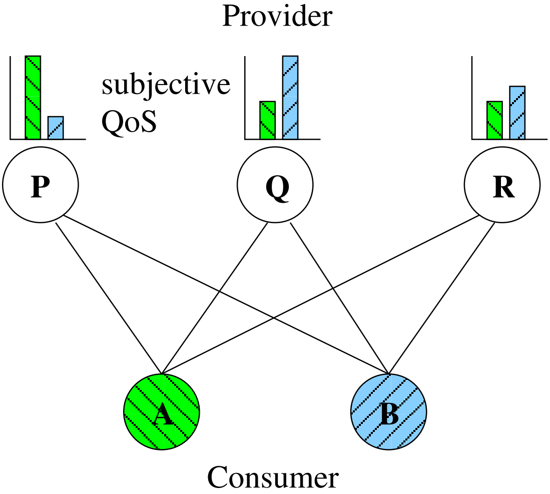

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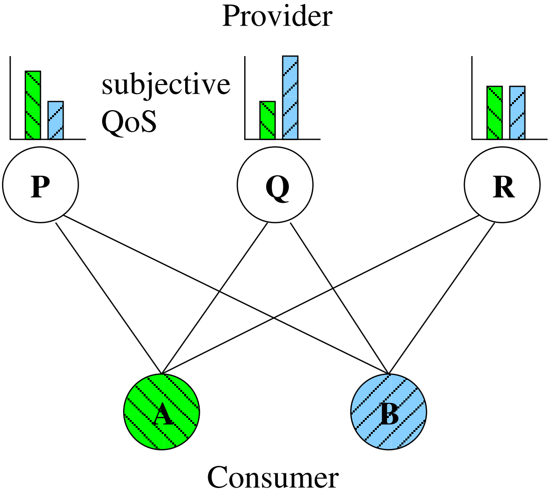

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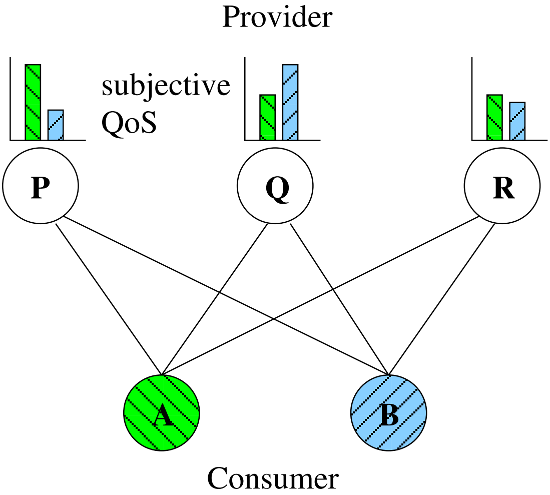

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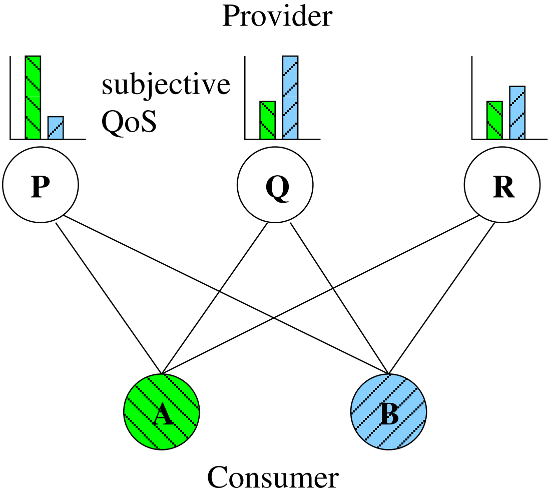

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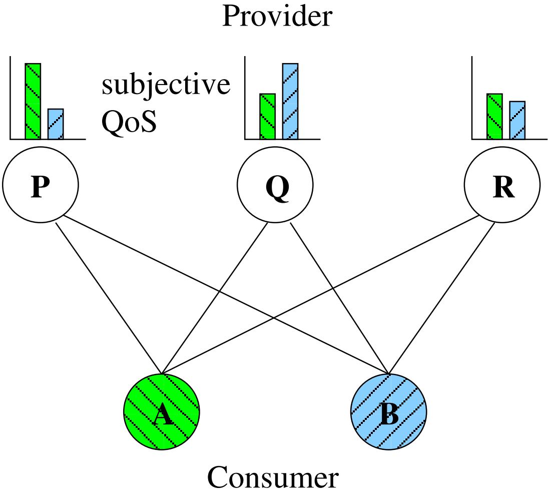

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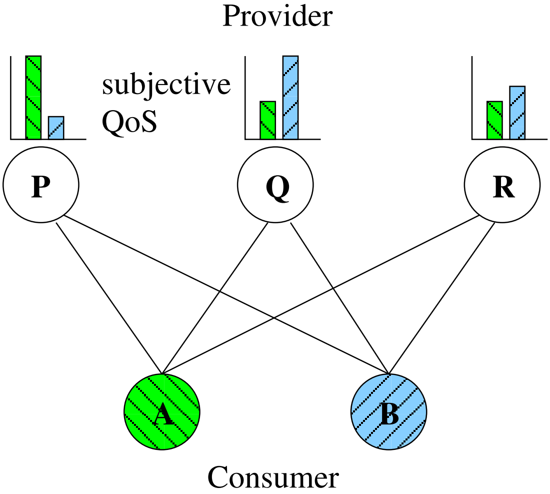

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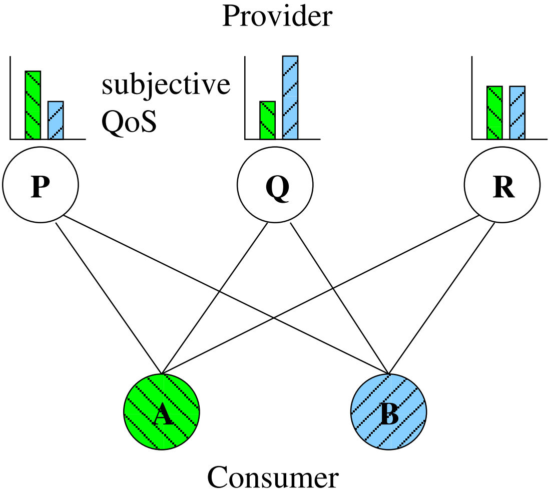

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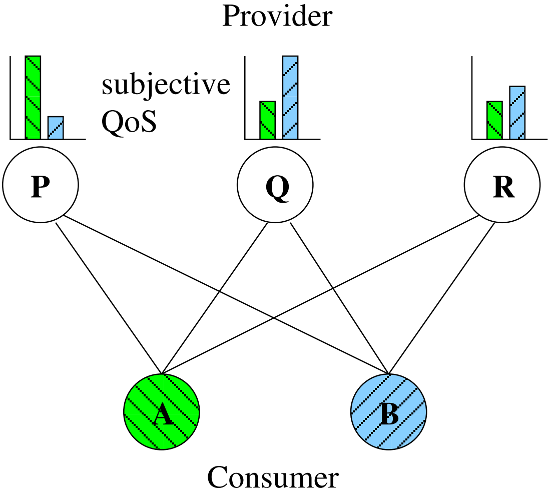

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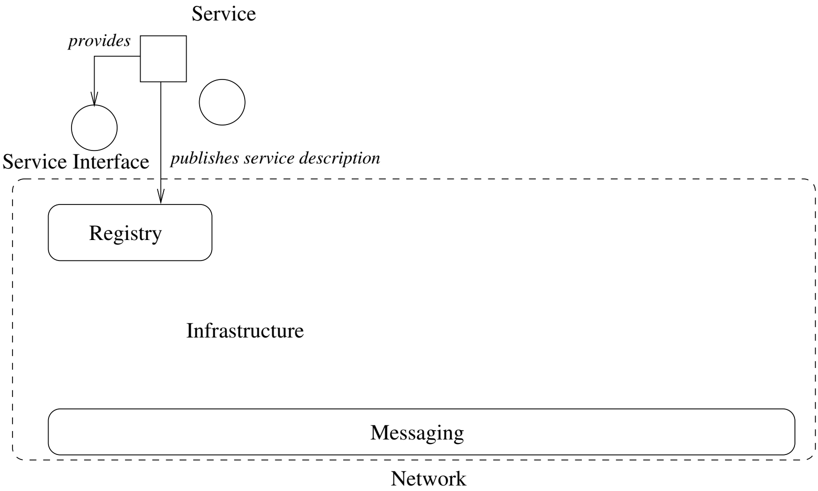
Service Architecture

What components are required to base Service Selection on Dynamic QoS?



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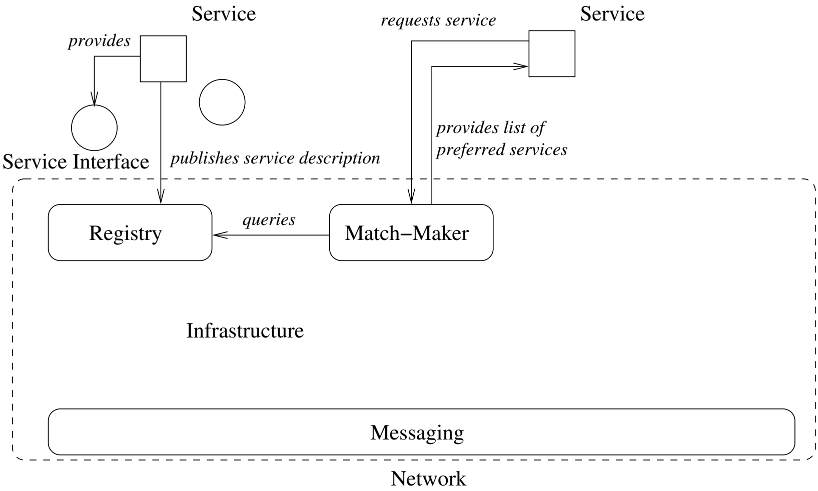

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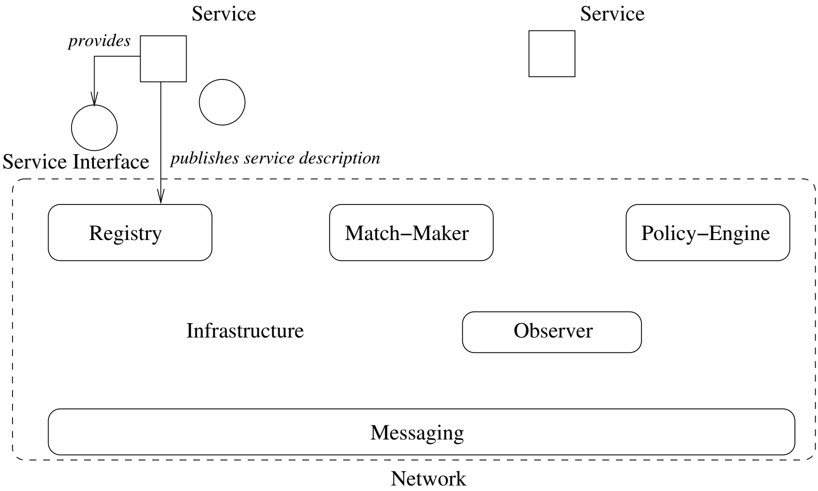

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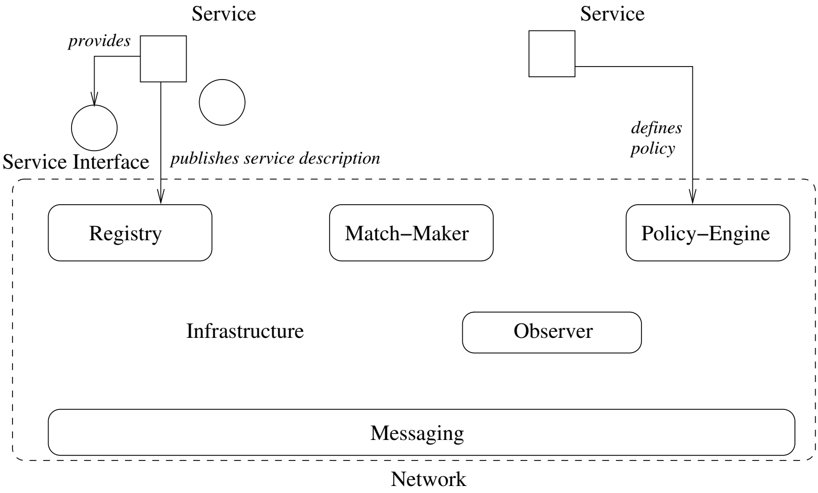

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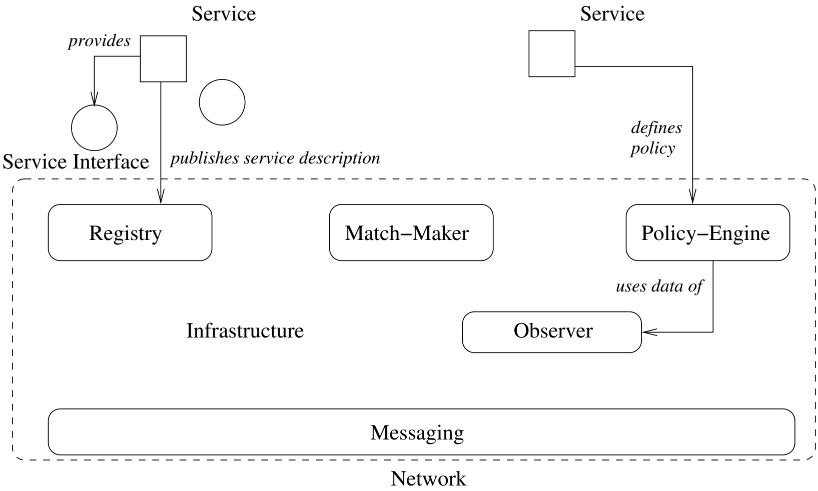

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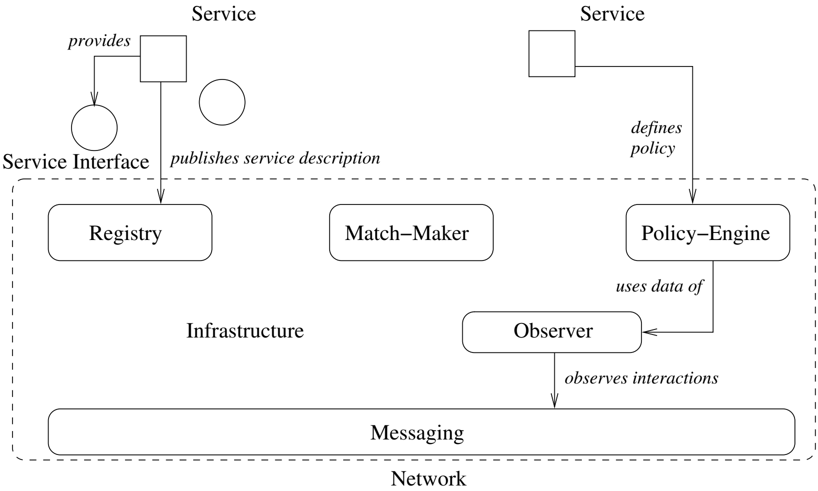

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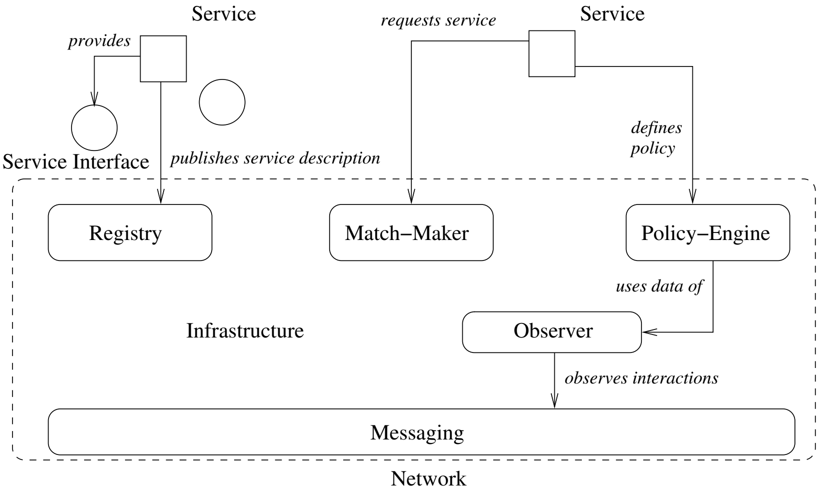

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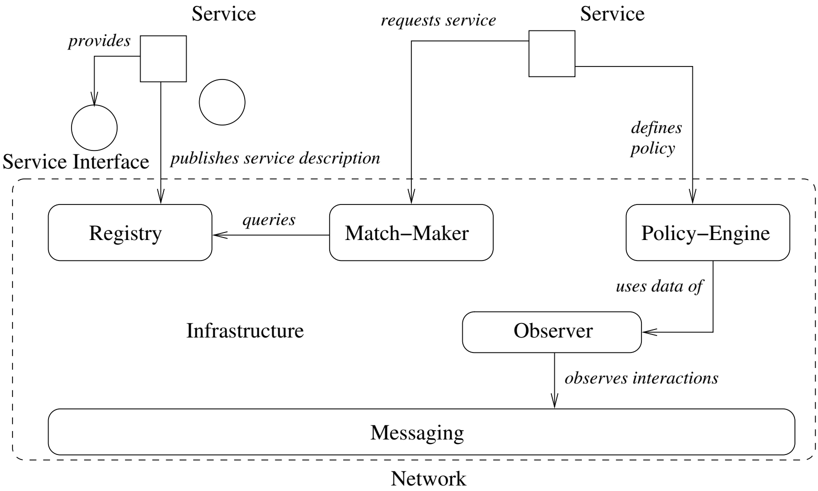

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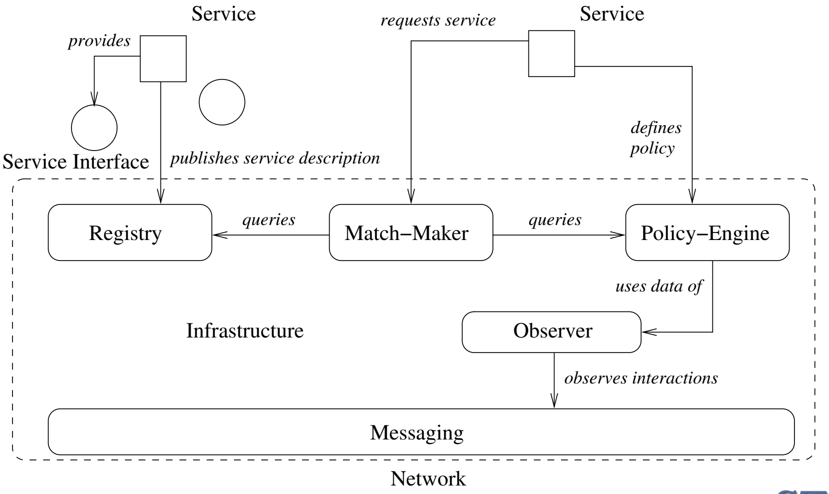

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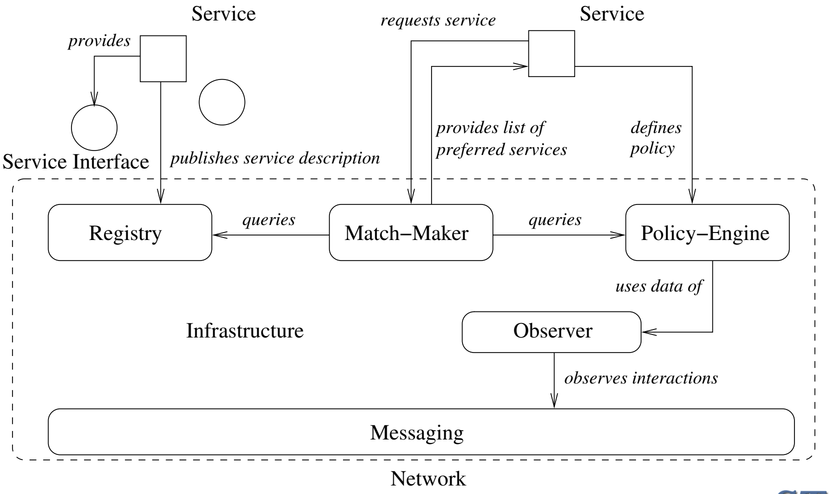

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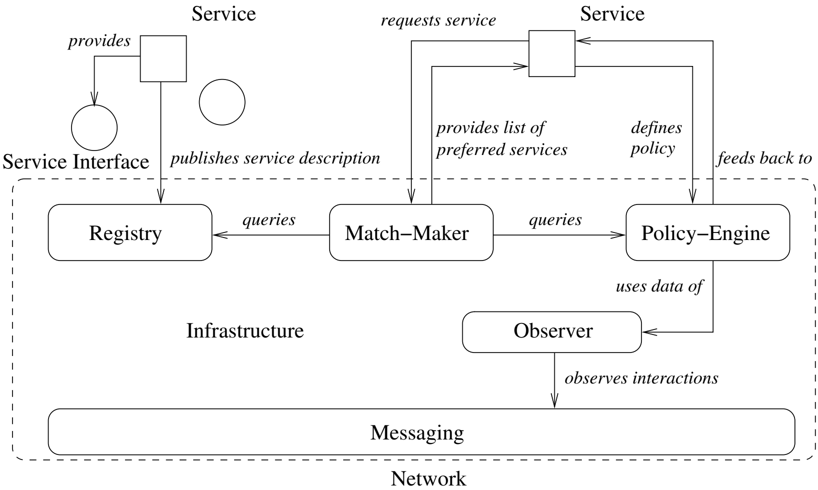

Policy & Preferences

How can we define subjective preferences as policy?

- Previous work on access control policies:
  - expressed in terms of rules.
  - rules map from observed behaviours to access decisions.
  - rules are composed into policies.
  - policies can change dynamically over time/ with events.
- This was extended with the notion of:
  - *mutable* attributes (Park 2004 [2])
  - pre, post and ongoing update *actions* (Sandhu 2004 [1])
- We express a preference rule as:

when *b* [**increase** | **decrease**] **preference**
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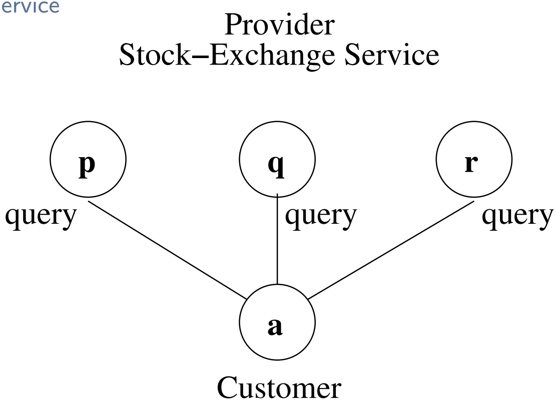

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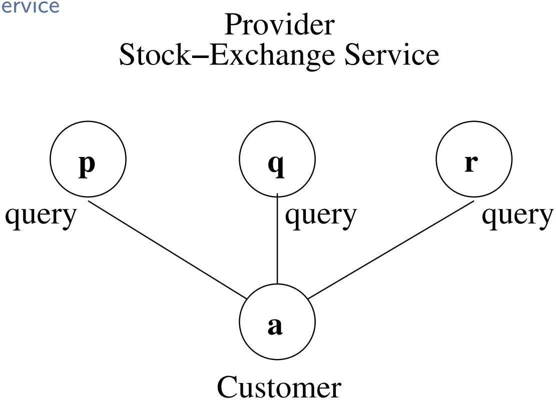

Customer **a** registers the following policy:

```
scope ([#a],[#p,#q,#r],[#query]) : {
  new ConsumerPolicy()
}
```

Example

Defining the policy

```
policy ConsumerPolicy {
  require Function int rt(Subject, Object, Action)
  define static int little = 1 /* ... */
  define S.O.A.pref = 0
  define Update incr(int x, int y) { x := x + y }

  perform incr(S.O.A.pref, medium)
  once after (S,O,A)
  when 10: (always rt(S,O,A) <= 2)

  perform decr(S.O.A.pref, little)
  once after (S,O,A)
  when 10: (sometime rt(S,O,A) >= 5)

  perform decr(S.O.A.pref, strong)
  after (S,O,A)
  when 0: (rt(S,O,A) >= 10)
}
```

Example

A Stock-Quote Service – Evaluation of the Policy

For simplicity we only look at provider **p**:

request	1	2	3	4	5	6	7	8	9	10	11	12	...
rt/sec	11	2	2	1	1	1	1	2	2	2	2	5	...
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request	1	2	3	4	5	6	7	8	9	10	11	12	...
rt/sec	11	2	2	1	1	1	1	2	2	2	2	5	...
#a.#p.pref	0	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-1	-2

No policy rule fires

Example

A Stock-Quote Service – Evaluation of the Policy

For simplicity we only look at provider **p**:

request	1	2	3	4	5	6	7	8	9	10	11	12	…
rt/sec	11	2	2	1	1	1	1	2	2	2	2	5	…
#a.#p.pref	0	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-1	-2

```
  perform incr(S.O.A.pref, medium)
  once after (S,O,A)
  when 10: (always rt(S,O,A) <= 2)
```

Example

A Stock-Quote Service – Evaluation of the Policy

For simplicity we only look at provider **p**:

request	1	2	3	4	5	6	7	8	9	10	11	12	…
rt/sec	11	2	2	1	1	1	1	2	2	2	2	5	…
#a.#p.pref	0	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-1	-2

```
  perform incr(S.O.A.pref, medium)
  once after (S,O,A)
  when 10: (always rt(S,O,A) <= 2)
```

Example

A Stock-Quote Service – Evaluation of the Policy

For simplicity we only look at provider **p**:

request	1	2	3	4	5	6	7	8	9	10	11	12	...
rt/sec	11	2	2	1	1	1	1	2	2	2	2	5	...
#a.#p.pref	0	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-1	-2

```
  perform decr(S.O.A.pref, little)
  once after (S,O,A)
  when 10: (sometime rt(S,O,A) >= 5)
```

Example

A Stock-Quote Service – Evaluation of the Policy

For simplicity we only look at provider **p**:

request	1	2	3	4	5	6	7	8	9	10	11	12	...
rt/sec	11	2	2	1	1	1	1	2	2	2	2	5	...
#a.#p.pref	0	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-1	-2

```
perform decr(S.O.A.pref, little)
once after (S,O,A)
when 10: (sometime rt(S,O,A) >= 5)
```

Example

A Stock-Quote Service – Evaluation of the Policy

For simplicity we only look at provider **p**:

request	1	2	3	4	5	6	7	8	9	10	11	12	...
rt/sec	11	2	2	1	1	1	1	2	2	2	2	5	...
#a.#p.pref	0	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-1	-2

- Preferences are updated continuously based on experience.
- Rules define:
  - The time/context of observations are defined.
  - The condition for updates as a behaviour of these observations.
  - The effect that an update has on policy attributes.
- The policy attribute (e.g. #a.O.#query.pref) can be seen as an ordering of service providers O $\in$ [#p, #q, #r].

Conclusion

The nice ...

- Architecture
  - Service Selection is made based on *dynamic* QoS attributes.
  - Support is provided at the infrastructure level, viz.
    - Observations can be made "objectively".
    - More observations can be taken into account (if authorisation constraints permit).
    - Policies are continuously evaluated.
    - Service Selection is transparent to the consumer.
    - Feedback to consumer on (significant) changes.
- Policies
  - Formal semantics: Validation & Verification of properties.
  - Define QoS declaratively.
  - QoS is defined *subjectively* by each consumer taking past experiences into account.
  - Integrate nicely with access control policies defining who can observe dynamic attributes of a consumers interactions.

Conclusion

.. and ugly

- Overhead on the infrastructure.
- Communication of non-local observations diminishes bandwidth.
- Missing methodology to define preference rules and update actions.
- Validation that the policy captures the intent.
- More potential for policy conflicts.
- Update actions complicate semantics.

Questions?

... are appreciated!

Contact:

Helge Janicke
(heljanic@dmu.ac.uk)

Monika Solanki
(monika@doc.ic.ac.uk)

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