The BRO Framework

The Bridging Function Chain Re-assignment & Orchestration Framework

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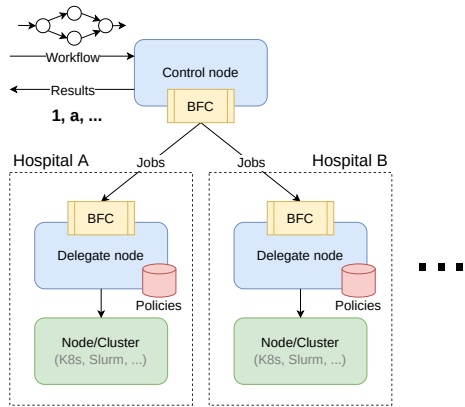
Toward Personalised Medicine

- Healthcare data is inaccessible (locked in silos)
  - Small dataset sizes $\rightarrow$ combining is desirable
- **The EPI Project**[1] [1] aims to "unlock" these data silos.
  - ...while preserving the privacy and security requirements.

[1] https://enablingpersonalizedinterventions.nl

Toward Personalised Medicine

- *How?* → The **Brane** framework[2]...
  - Federated workflow execution system
  - ...but with policies to manage data access
- ...and the **EPI Framework** [3]
  - Network security through virtual network functions (Bridging Function Chains, BFCs)



[1] https://wiki.enablingpersonalizedinterventions.nl

Since Our Last meeting

Progress report:

- PoC progress
- Research progress
  - ⇒ Defining the provisioning puzzle pieces
  - ⇒ Provisioning problem statement
  - ⇒ Investigating tools and algorithms
- Experiment and evaluation plans
- BRANE-EPIF integration
- Paper and presentation (eScience2022)

Overview

Provisioning Challenges

- Enforce network & security policies
- Provide reliable & optimal network performance
- Use-cases have various network utilization profiles
- BFCs have to be available on-demand with high availability

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⇒ Elasticity required of services chaining and resources needed / use case
⇒ We need fast deployment, high reusability, low resource wastage, and QoS.

Problem Statement

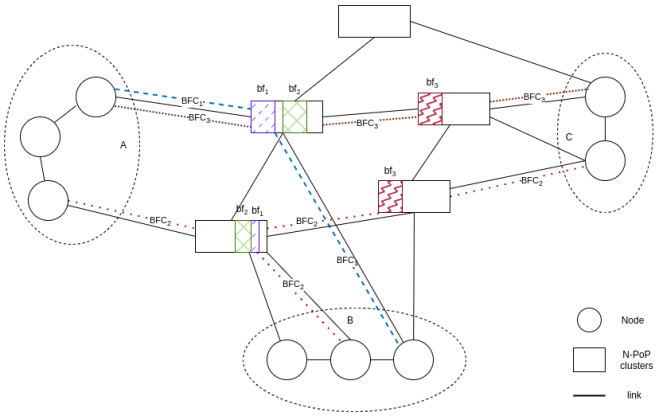
Profiling of BFC service chains:
→ requirements while running microservices / use cases

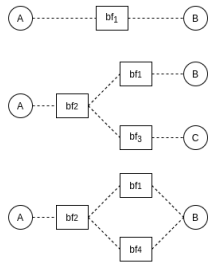
Mapping BFC requests to running microservices:
→which microservices' running to re-assign,
maximising CPU utilisation, and services' performance?

Allocation of N-PoP:
→ when the running microservices can't be assigned to a service chain

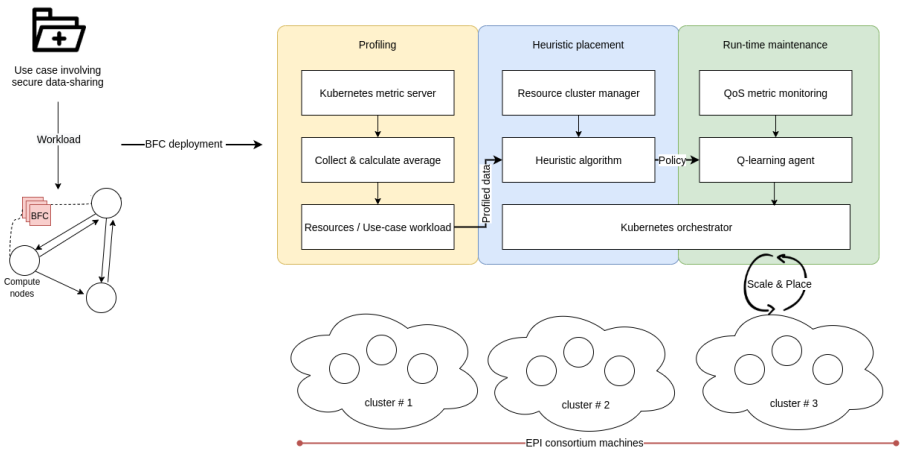
Chaining the microservices:
→ assign available (routable) links and host virtual links.

Example Network





Proposed Strategy



Algorithm Design

Intelligent agents ought to take actions in an environment in order to maximize the notion of cumulative reward.

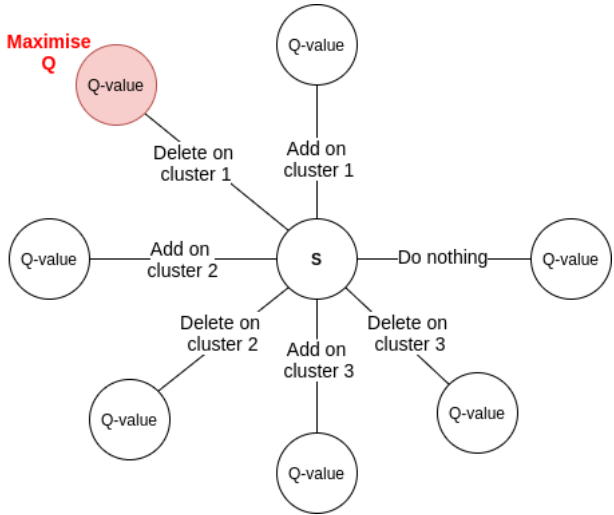
Configurations:

1. Action Space: *add*|*delete* a replica of service $bf_1|bf_2|bf_3$ to cluster 1|2|3
2. State: CPU utilisation of nodes, placement of services, number of replicas/cluster, QoS vs SLA.
3. Reward function: $R_{all} = \alpha R_{res} + \beta R_{perf}$

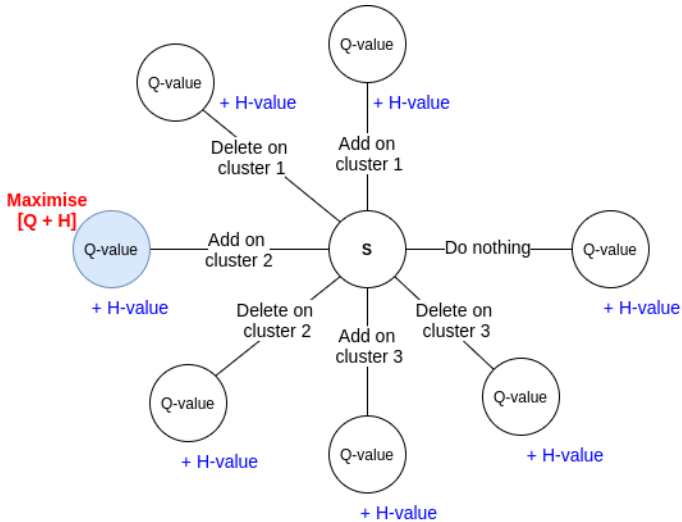
Highs and lows:

1. With this approach, we can configure the agent to adapt the placement and allocation of resources to the use case requested.
2. We re-assign new requests to running microservices, if possible
3. This is still slow to converge
4. random actions to explore the environment might degrade performance
5. Might need offline learning

Heuristic-boosted RL



Heuristic-boosted RL



Conclusion & Future Work

The EPI Framework provides network security policy enforcement points via
→ BFC provisioning & placement

- An approach for provisioning Bridging Function Chains (BFCs) during placement and at runtime within the EPI Framework.
  1. Dynamic scaling and provisioning using ML
  2. Heuristically optimised using offline profiling results
  3. Based on available/used resources & QoS-metrics
- Heuristic-based vs ML-based vs Heuristic-boosted
- Framework evaluations with threat and trust model.
  1. Subject probability vs objective threat
  2. Defining data sharing scenarios.

Thanks for listening

[1] J. A. Kassem, C. De Laat, A. Taal and P. Grosso(2020)
The EPI Framework: A Dynamic Data Sharing Framework for Healthcare Use Cases
IEEE Access vol. 8, pp. 179909-179920

[2] O. Valkering, R. Cushing and A. Belloum(2021)
Brane: A Framework for Programmable Orchestration of Multi-Site Applications
IEEE 17th International Conference on eScience pp. 277-282

[3] J. A. Kassem, O. Valkering, A. Belloum and P. Grosso(2021)
EPI Framework: Approach for Traffic Redirection Through Containerised Network Functions
IEEE 17th International Conference on eScience pp. 80-89