

Managing Federations and Cooperative Management

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1 Motivation

Welcome to this special issue of the Journal of Network and Systems Management, which focusses on Management of Federations and Cooperative Management.

Over many years the research community has been actively investigating how network management systems can be evolved to achieve the flexibility and adaptability required to efficiently operate increasingly complex, heterogeneous and interconnected networks. Notable amongst these efforts has been the vision of autonomic networking [3, 7] in which a network has the ability to self-govern its behaviour within the constraints of human-specified business goals. Autonomic networking promises a much more flexible approach to management that seeks to both allow systems to automatically adapt offered services or resources in response to user or environmental changes and to reduce operational expenditure for network operators.

Whilst significant progress has been made, this work has mainly focused on management in the context of single, well-defined network domains. Relatively little work has been done on how management systems can be federated across management domains to provide end-to-end management of communications services [6]. Current network management systems do perform some coordination

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across domains, but this is limited in scope to a small number of pre-defined information exchanges. This special issue addresses how management systems should be designed to incorporate capabilities supporting the negotiation and lifecycle management of federations involving networks, service providers and service consumers.

There are many management approaches and technologies that can be applied across organisational boundaries. These range from algorithmic approaches which adapt to the observed behaviour of third-party systems, based on game-theoretic approaches or other predictive models, to explicit organisational federations which adopt coherent solutions and management models to facilitate interoperability among multiple independent organisations. In particular, recent years have seen a wealth of research and technology developments into federated and cooperatively managed systems:

- Research in policy based management systems and Service Level Agreement (SLA) frameworks increasingly addresses sophisticated federated, inter-organisational relationships, particularly as they relate to SLA usage in cloud computing environments;
- Cooperative management research investigates how algorithmic approaches can facilitate non-destructive cross-domain inter-operation in the absence of explicit coordination;
- Grid and cloud computing research is concerned with the problem of making heterogeneous distributed computing resources available in flexible ways (including across administrative boundaries) to provide infrastructure as a service;
- Federated security research investigates the problems of providing trusted mechanisms on top of heterogeneous distributed security systems;
- Service Oriented Architectures and Internet mash-ups are increasingly enabling applications to be constructed based upon a diversity of components, drawn from multiple organisations systems;
- Data federation research investigates how data from heterogeneous sources can be aggregated into a normalised view that can be seamlessly leveraged by multiple applications;
- Research into lifecycles used to model multi-role Cloud Computing environments is investigating interoperation and federation among multiple artifact lifecycles;
- Model Driven Engineering (MDE) research is developing techniques that can be used to facilitate the specification, deployment and management of federations between heterogeneous and independent organisations.

This work has led to a growing realisation of the range of significant, complex issues which must be addressed in all technologies and applications that involve explicitly or implicitly federated organisations. In an effort to identify and address these issues, a group of network and service management researchers organised the IFIP/IEEE International Workshop on Managing Federations and Cooperative Management in 2011 [4, 5]. One of the outputs from this workshop was the proposal

of this JNSM special issue, which seeks to provide an in-depth view of significant research outputs on the management of federations.

2 Article summaries

For this special issue we have selected four articles, addressing different challenges relating to management of federations.

The first article, “Managed Semantic Interoperability for Federations,” by Brennan et al., recognises that achieving semantic interoperability between components is a pre-requisite to federating IT systems. The authors address dynamic federations in which autonomous members with heterogeneous data or service description schemata are admitted. The paper presents a process, model and algorithms to manage the lifecycle, refinement and dynamic combination of semantic mappings for these data and service description schemata that harness federation context and automated correspondence pattern recognition. The work is notable for its emphasis on maximising the degree to which the generated executable mapping components can be reused by multiple mappings.

The second article, “Ontology-based Semantic Priority Scheduling for Multi-domain Active Measurements,” by Calyam et al., also proposes the use of semantic models, albeit for a very specific purpose—the development of an ontology-based semantic priority scheduling algorithm that prioritises measurement requests from multiple sources. The article addresses the deployment of openly accessible multi-domain active measurement frameworks, such as perfSonar, which results in users competing for network measurement resources. The semantic priority scheduling algorithm prioritises measurement requests based on user roles, user sampling preferences, resource policies, and oversampling mitigation factors. The performance evaluation results presented, which are based on real-world measurement request parameters and multi-domain considerations, suggest that the proposed scheme outperforms previously proposed approaches, in particular significantly improving the satisfaction ratio among users.

The penultimate article, “An Iterative Approach to Trustable Systems Management Automation and Fault Handling,” by McLarnon et al., notes that automated management systems are increasingly being used to automate common management tasks for large-scale distributed computing systems, but points out that they come with some disadvantages, especially when it is necessary to manage resources in external management domains. In particular, they argue that the abstraction that these systems create between system administrators and the managed resources mean that when an error occurs or a task fails it becomes significantly more difficult to identify the root cause. To counter this, the article proposes an approach to automated systems management in which the administrator is able to transition control of management tasks to an automation solution in stages. Furthermore, the authors describe how analyses of fault condition patterns can be used in future task iterations to automatically determine the completion state. It is clear that automated management systems whose operation can be governed by administrators in the

manner described will be necessary to manage the increased complexity of federated network environments.

The final article, “End-to-End Resource Management for Federated Delivery of Multimedia Services,” by Famaey et al., addresses how federation techniques can provide Quality-of-Service (QoS) aware delivery of streaming multimedia across the Internet. The article proposes an automated mechanism to set up end-to-end federations comprising a content provider, its customers and the intermediary network domains that connect them. Moreover, a federated resource reservation algorithm is presented, which facilitates identification of the optimal set of stakeholders and resources to include within such a federation. Another significant addition is the ability to harness intermediate storage sites to be included in the federation in order to increase the QoS provided to customers. As a whole, the framework offers a compelling argument for the benefits of introducing flexible federation capabilities into future networks.

3 Conclusion

In addition to the articles in this special issue, readers interested in management of federations may also wish to explore the articles published in the December 2013 special mini-issue of JNSM on Efficient Management of Loosely Cooperative Service Networks [1] and in the November 2013 special section of IEEE Communications Magazine on Monitoring and Troubleshooting Multi-domain Networks using Measurement Federations [2].

We would like to take the opportunity to thank the authors who submitted very high quality manuscripts to the special issue and who spent significant efforts to revise their manuscripts in line with reviewers’ comments. We also would like to thank the anonymous reviewers who volunteered to review the manuscripts and who provided insightful and useful feedback to the authors. Finally, we would like to acknowledge the efforts of the JNSM editor-in-chief, Prof. Deep Medhi, who gave us the opportunity to organise this special issue and who gave us very good advice and guidance. We hope that readers will find the selected articles useful for their own work on topics relating to management of federations.

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