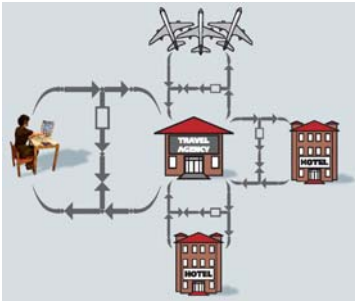
Coordination with Performance Guarantees

Farhad Arbab, Rob van der Mei, Sun Meng, Young-Joo Moon, Chrétien Verhoef

{F.Arbab,R.D.van.der.Mei,M.Sun,Y.J.Moon,C.G.Verhoef}@cwi.nl
http://www.cwi.nl/projects/CooPer

Inadequate Quality of Service (QoS) in software or services can lead to disguaranteed clients and loss of profits. How can we quantify the end-to-end QoS of dynamically composed services offered by different providers, ranging from telecommunications to medicine, e-commerce applications and embedded device applications? To satisfy users' end-to-end QoS requirements for such applications, CWI researchers have integrated software composition approaches and stochastic QoS models. This leads to software applications with better performance and cost savings.



Research Questions

- How can we specify end-to-end QoS in large-scale component-based distributed applications?
- What computational model can we implement in coordination middleware to enforce the specified QoS?
- How can we assess QoS in a compositionally constructed application and adapt to changes in the distributed environment?

QoS with Reo

We hope to build an approach for automatic generation of QoS models for service oriented applications. However, these models should be compositional for combining QoS of the services/connectors to derive the end-to-end QoS in distributed applications, and selecting appropriate services/connectors to satisfy users' QoS requirements. Furthermore, the compositionality should have a high architecture fidelity to real systems. According to these requirements, we use the compositional coordination model Reo, developed at CWI, as the basis for building the compositional calculus of QoS.

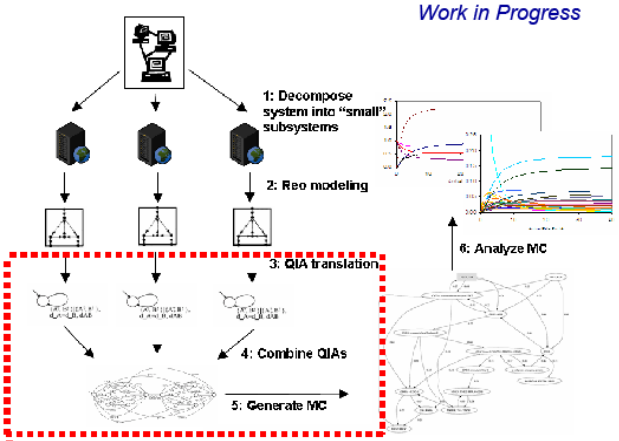
Approach

- Extending the compositional coordination model Reo with QoS properties
- Translation from the quantitative Reo circuits to CTMCs for performance analysis using Quantitative Intensional Automata

This results in the following Reo QoS "Calculus":

1. Define / recognize subsystems
2. Model system(s) in Quantitative Reo
3. Translate Reo model(s) into Quantitative Intensional Automata (QIA)
4. Combine QIA models
5. Generate CTMC from QIA model

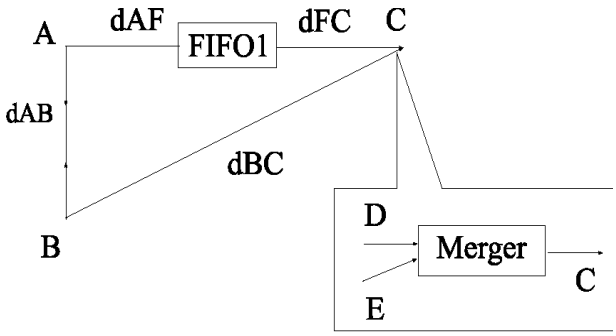
Work in Progress



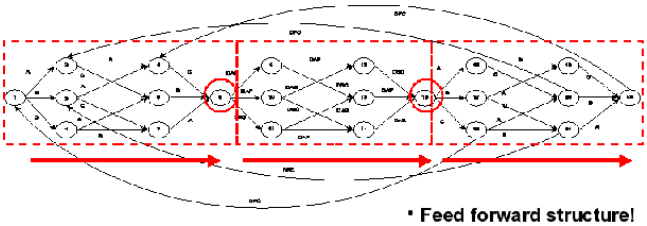
Automated CTMC generation

Results

- An integration of the coordination language Reo with QoS aspects can be used to compositionally specify QoS properties. We use Quantitative Intensional Automata as a computational model for this compositional QoS coordination language
- A method to quantify the performance of complex coordination systems using an automatic translation from Reo into CTMC
- Smart "solving" of the resulting CTMC using the synchronizing properties of Reo



Special CTMC structures



- **Feed forward structure!**
- **Synchronisation points!**

Conclusion

This research is a step toward a higher level QoS model for large-scale distributed service-oriented applications. The resulting compositional QoS models integrate software composition approaches and QoS models by adding the QoS dimension to component connector technology. This provides a powerful means to measure, predict and monitor end-to-end QoS metrics in software systems. Our framework can also be used to produce more effective models for performance analysis.

Acknowledgements

This research is funded by the Dutch National Organization for Scientific Research (NWO), through project CooPer (600.643.000.05N12).