Information in the following tables has been used during derivation of MLSAC metamodel.

Appendix A

The list of identified studies from literature review for framework development

Study ID	Authors and title	Channel	Source	Year	Type*	Affiliation	Validation
[S1]	Krasteva, I., S. Stavru, et al., "*Agile Model-Driven Modernisation to the Service Cloud*"	Conference	ThinkMind	2013	Methodology	Rila Solutions EAD, Bulgaria	Case study
[S2]	Beserra, P. V., A. Camara, et al, "*Cloudstep: A step-by-step decision process to support legacy application migration to the cloud*"	Workshop	IEEE	2012	Decision Making Framework	Brasil	Partial example
[S3]	Mohagheghi, P., "*Software Engineering Challenges for Migration to the Service Cloud Paradigm: Ongoing Work in the REMICS Project*"	Conference	IEEE	2011	Method	SINTEF ICT, Norway	Case study
[S4]	Conway, G. and E. Curry, "*The IVI Cloud Computing Life Cycle*"	Book Chapter	Springer	2013	Method	Innovation Value Institute, National University of Ireland	Partial example
[S5]	Khajeh-Hosseini, A., D. Greenwood, et al, "*Cloud migration: A case study of migrating an enterprise it system to iaas*"	Conference	IEEE	2010	Experience	Cloud Computing Co-laboratory School of Computer Science University of St Andrews, UK	Case study
[S6]	Tran, V., J. Keung, et al, "*Application migration to cloud: a taxonomy of critical factors*"	Workshop	ACM	2011	Experience	CSE, University of New South Wales, Australia	Explorative experience
[S7]	Khajeh-Hosseini, A., D. Greenwood, et al, "*The cloud adoption toolkit: supporting cloud adoption decisions in the enterprise*"	Journal	Wiley Online Library	2012	Approach	Cloud Computing Co-laboratory, School of Computer Science University of St Andrews, UK	Case study
[S8]	Kundra, V., "*Federal cloud computing strategy*"	White Paper	Online	2011	Decision Making Framework	USA	Case study
[S9]	Chauhan, M. A. and M. A. Babar, "*Towards Process Support for Migrating Applications to Cloud Computing*"	Conference	IEEE	2012	Method	Software & Systems Group IT University of Copenhagen, Denmark	Case study
[S10]	Strauch, S., et al. "*Migrating eScience Applications to the Cloud: Methodology and Evaluation*"	Journal	CRC Press / Taylor & Francis	2014	Method	Institute of Architecture of Application Systems, University of Stuttgart, Germany	Case study

[S11]	S. Strauch, V. A., D. Karastoyanova, F. Leymann, "*Migrating Enterprise Applications to the Cloud: Methodology and Evaluation*"	Journal	Perpetual Innovation Media	2014	Method	Institute of Architecture of Application Systems, University of Stuttgart, Germany	Case study
[S12]	Leymann, F., et al., "*Moving applications to the cloud: An approach based on application model enrichment*"	Journal	World Scientific	2011	Approach	Institute of Architecture of Application Systems, University of Stuttgart, Germany	Case study
[S13]	Zhang, W., et al., "*Migrating legacy applications to the service Cloud*"	Conference	Unipub	2009	Method	SINTEF, Norway	Case study
[S14]	Frey, S., et al., "*Automatic conformance checking for migrating software systems to cloud infrastructures and platforms*"	Journal	Wiley InterScience	2011	Approach	Software Engineering Group, University of Kiel, Germany	Simulation
[S15]	Miranda, J., et al., "*Assisting Cloud Service Migration Using Software Adaptation Techniques*"	Conference	IEEE	2013	Method	Dept. of Information Technology and Telematic Systems Engineering, University of Extremadura, C´aceres, Spain	Explorative experience
[S16]	Fehling, C., et al, "*Service Migration Patterns--Decision Support and Best Practices for the Migration of Existing Service-Based Applications to Cloud Environments*"	Conference	IEEE	2013	Pattern and Method	Institute of Architecture of Application Systems, University of Stuttgart Stuttgart, Germany	Case study
[S17]	Tak, B. C., et al., "*To move or not to move: the economics of cloud computing*"	Conference	USENIX Association	2011	Experience	The Pennsylvania State University, USA	Simulation
[S18]	Guillén, J., et al., "*A service-oriented framework for developing cross cloud migratable software*"	Journal	ScienceDirect	2013	Approach	GloIn, Calle Azorín 2, Cáceres, Spain	Case study
[S19]	Ardagna, D., et al., "*Modaclouds: A model-driven approach for the design and execution of applications on multiple clouds*"	Workshop	MISE	2012	Approach	Politecnico di Milano, Italy	Simulation
[S20]	Hajjat, M., et al. "*Cloudward bound: planning for beneficial migration of enterprise applications to the cloud*"	Conference	ACM	2010	Approach	Purdue University, USA	Simulation
[S21]	Moens, H., et al., "*Design and evaluation of a hierarchical application placement algorithm in large scale clouds*"	Conference	IEEE	2011	Approach	Ghent University - IBBT Department of Information Technology, Belgium	Simulation
[S22]	SUN, K., Li, Y., "*Effort Estimation in Cloud Migration Process*"	Conference	IEEE	2012	Conceptual Model	IBM Research - China	Case Study

[S23]	Rabetski, P. and G. Schneider, "*Migration of an On-Premise Application to the Cloud: Experience Report*"	Conference	Springer	2013	Approach	Department of Computer Science and Engineering Chalmers University of Technology, and the University of Gothenburg Gothenburg, Sweden	Explorative experience
[S24]	C.,Pahl, H. Xiong, et al., "*A Comparison of On-Premise to Cloud Migration Approaches*"	Conference	Springer	2013	Approach	IC4, Dublin City University, Dublin, Ireland	Experience
[S25]	Laszewski, T. and P. Nauduri, "*Migrating to the Cloud: Oracle Client/Server Modernisation*"	-	Elsevier	2012	Method	USA	Explorative experience
[S26]	Guo, X., "*Evaluation of a Methodology for Migration of the Database Layer to the Cloud based on an eScience Case Study*"	Thesis	-	2013	Method	Institute of Architecture of Application Systems University of Stuttgart, German	Two case studies
[S27]	Ahmad, Aakash, and Muhammad Ali Babar. "*A framework for architecture-driven migration of legacy systems to cloud-enabled software*"	Conference	ACM	2014	Approach	IT University of Copenhagen, Denmark	Retrospective Studies
[S28]	Ridha, Gadhgadhi, Khazri Saida, and Cheriet Mohamed. "*OPENICRA: Towards A Generic Model for Automatic Deployment of Applications in the Cloud Computing*"	Journal	Institute of Advanced Engineering and Science	2013	Approach	Multimedia Communication in Telepresence, Montréal (QC), Canada	Two Case Studies
[S29]	Council, C. S. C., "*Migration applications to public Cloud Services: roadmap for success*"	-	Cloud Standards Customer Council	2013	Method	Cloud Standards Customer Council	Industrial Experience
[S30]	Menzel,M., "*(MC2) 2 : A Generic Decision-Making Framework and its Application to Cloud Computing*"	Journal	Wiley Online Library	2012	Decision Making Framework	Research Center for Information Technology Karlsruhe Institute of Technology, Karlsruhe, Germany	Simulation
[S31]	Quang Hieu, V. and R. Asal, "*Legacy Application Migration to the Cloud: Practicability and Methodology*"	World Congress	IEEE	2012	Pattern	ETISALAT BT Innovation Centre Khalifa University, UAE, United Arab Emirates	Explorative experience
[S32]	H.A.Huru, "*MILAS: Modernsing Legtacy Applications towards Service Oriented Architecture (SOA) and Software as a Service (SaaS)*"	Thesis	-	2009	Experience	University of Oslo	Two Case Studies
[S33]	Benguria, G., Elvesæter, B., Ilieva, S., "*REuse and Migration of legacy applications to Interoperable Cloud Services"*	Technical Report	Remics Consortium	2013	Method	Remics Consortium	Experience

[S34]	Tang,K., Zhang J.M, Feng, C.H, "*Application Centric Lifecycle Framework in Cloud*"	Conference	IEEE	2011	Method	IBM Research China	Illustrative Example
[S35]	Bezemer, C.-P., et al., "*Enabling multi-tenancy: An industrial experience report*"	Conference	IEEE	2010	Pattern	Delft University of Technology, The Netherlands	Explorative experience
[S36]	Guo, C. J., et al., "*A framework for native multi-tenancy application development and management*"	Conference	IEEE	2007	Pattern	IBM China Research Laboratory, Beijing, China	Explorative experience
[S37]	Mietzner, R., et al., "*Cafe: A generic configurable customisable composite cloud application framework*"	Book Chapter	Springer	2009	Approach	Institute of Architecture of Application Systems University of Stuttgart, Germany	Illustrative Example
[S38]	Strauch, S., Andrikopoulos, V., Gómez Sáez, S., Leymann, F. "*Transparent Access to Relational Databases in the Cloud Using a Multi-Tenant ESB*"	Conference	SciTePress	2014	Approach	Institute of Architecture of Application Systems University of Stuttgart, Germany	Experiment
[S39]	Marimuthu C, K. Chandra Sekaran, "*Software Development for Cloud: An Experiential Study*"	Conference	IEEE	2013	Experience	National Institute of Technology Karnataka Mangalore, Karnataka, India	Industrial Experience
[S40]	Anstett, T., et al., "*Towards BPEL in the Cloud: Exploiting Different Delivery Models for the Execution of Business Processes*"	Conference	IEEE	2009	Pattern	Institute of Architecture of Application Systems, University of Stuttgart, Germany	Explorative experience
[S41]	Varia, J., "*Architecting for the cloud: Best practices*"	Book	Amazon	2010	Experience	USA	Explorative experience
[S42]	Bessani, A., et al., "*DepSky: dependable and secure storage in a cloud-of-clouds*"	Journal	ACM	2013	Approach	University of Lisbon, Faculty of Sciences, Portugal	Simulation
[S43]	Curino, C., et al., "*Relational cloud: A database-as-a-service for the cloud*"	Technical Report	MIT	2011	Experience	Massachusetts Institute of Technology. Computer Science and Artificial Intelligence Laboratory, USA	Simulation
[S44]	Binz, Leymann et al. , "*CMotion: A framework for migration of applications into and between clouds*"	Conference	IEEE	2011	Method	Institute of Architecture of Application Systems University of Stuttgart, Germany	Illustrative Example
[S45]	Fehling, C., et al., "*Pattern-based development and management of cloud applications*"	Journal	Future Internet	2012	Pattern	Institute of Architecture of Application Systems, University of Stuttgart, Germany	Explorative experience

[S46]	Chauhan, M. A. and M. A. Babar, "*Migrating Service-Oriented System to Cloud Computing: An Experience Report*"	Conference	IEEE	2011	Experience	School of Innovation, Design, and Engineering Mälardalen University, Sweden	Explorative experience
[S47]	Zagarese, Q., et al., "*Enabling advanced loading strategies for data intensive web services*"	Conference	IEEE	2012	Experience	Department of Engineering University of Sannio Benevento, Italy	Simulation
[S48]	Cisco Systems, *"Planning the Migration of Enterprise Applications to the Cloud"*	White Paper	Cisco Systems	2010	Experience	Cisco Systems	Experience
[S49]	Duplyakin, D., et al., "*Rebalancing in a multi-cloud environment*"	Workshop	ACM	2013	Approach	University of Colorado, USA	Simulation
[S50]	Ali Babar, M., Chauhan, M.A., "*A Tale of Migration to Cloud Computing for Sharing Experiences and Observations*"	Workshop	ACM	2011	Experience	IT University of Copenhagen, Copenhagen, Denmark	Experience
[S51]	Pahl, C. and H. Xiong, "*Migration to PaaS clouds-Migration process and architectural concerns*"	Conference	IEEE	2013	Experience	the Irish Centre for Cloud Computing and Commerce, Ireland	Expert interviews and focus groups
[S52]	Saleh,E., Shaabani,N., Meinel, C., "*A Framework for Migrating Traditional Web Applications into Multi-Tenant SaaS*"	Conference	IARIA	2012	Approach	Hasso-Plattner-Institut University of Potsdam Potsdam, Germany	Case Study
[S53]	Karampaglis,Z., Mentis,A., Rafailidis,F., Tsolakidis, P., Ampatzoglou, A., "*Secure Migration of Legacy Applications to the Web*"	Conference	Springer	2012	Approach	Department of Informatics, Aristotle University of Thessaloniki, Thessaloniki, Greece	Case Study
[S54]	Ilieva,S., Krasteva, I., Benguria, G., Elvesæter, B., "*Enhance your Model-driven Modernisation Process with Agile Practices*"	Workshop	SciTePress	2013	Method	IICT-BAS, Bulgaria	Case study
[S55]	Bahga, A., Madisetti, V.K., "*Rapid Prototyping of Multitier Cloud-Based Services and Systems*"	Journal	IEEE	2013	Method	Georgia Tech, USA	Simulation
[S56]	Logicalis, "*Logicalis, Migrating to the Cloud – A Logicalis How to Guide*"	White Paper	Logicalis	2013	Method	Logicalis	Experience
[S57]	Lindner, M.A., McDonald, F., Conway, G., Curry E., "*Understanding Cloud Requirements - A Supply Chain Lifecycle Approach*"	Conference	XPS	2011	Method	SAP Research, Palo Alto, USA	Illustrative Example
[S58]	Zhu.Y., "*A Platform for Changing Legacy Application to Multi-tenant Model*"	Journal	SERSC	2014	Approach	School of Economic and Management, Shiyou University, China	Case study
[S59]	Zhou, H., Yang, H.,Hugill, A., "*An Ontology-Based Approach to Reengineering Enterprise Software for Cloud Computing*"	Conference	IEEE	2010	Approach	Software Technology Research Laboratory De Montfort University	Case study

						Leicester, UK	
[S60]	Frey.S., Hasselbring, W., "*An Extensible Architecture for Detecting Violations of a Cloud Environment's Constraints During Legacy Software System Migration*"	Conference	IEEE	2011	Approach	Software Engineering Group University of Kiel, Germany	Case study
[S61]	Frey, S. and W. Hasselbring, "*The cloudmig approach: Model-based migration of software systems to cloud-optimised applications*"	Journal	GEOMAR	2011	Approach	Software Engineering Group University of Kiel, Germany	Simulation
[S62]	Banerjee, J., "*Moving to the cloud: Workload migration techniques and approaches*"	Conference	IEEE	2012	Method	IBM Kolkata, India	Explorative experience
[S63]	Nussbaumer, N. and X. Liu, *"Cloud Migration for SMEs in a Service Oriented Approach*"	Conference	IEEE	2013	Method	School of Computing Edinburgh Napier University Edinburgh, United Kingdom	Case study
[S64]	Menychtas, A., Santzaridou,C., Kousiouris, G., Varvarigou, T., "*ARTIST Methodology and Framework: A novel approach for the migration of legacy software on the Cloud*"	Conference	IEEE	2013	Method	National Technical University of Athens Athens, Greece	Experience
[S65]	Andrikopoulos, V., Binz, T., Leymann, F., Strauch, S., "*How to Adapt Applications for the Cloud Environment*"	Journal	Springer	2013	Experience	Institute of Architecture of Application Systems, University of Stuttgart, Germany	Experience
[S66]	S., Rajaraajeswari, R., Pethuru, "*Cloud Application Modernisation and Migration Methodology*"	Book Chapter	Springer	2013	Approach	Department of Master of Computer Applications, India	Illustrative example
[S67]	Duarte and Silva 2013, "*Cloud Maturity Model*"	Thesis	-	2013	Method	Tecnico University, Lisbon	Case studies, interviews
[S68]	Jamshidi, P., Ahmad, A., Pahl, C., "*Cloud Migration Research: A Systematic Review*"	Journal	IEEE	2013	Method	School of Computing, Dublin City University, Ireland	Retrospective studies
[S69]	La and Kim 2009, "*A systematic process for developing high quality saas cloud services. Cloud Computing*"	Book Chapter	Springer	2009	Method	Department of Computer Science Soongsil University, Korea	Feature evaluation
[S70]	Meiländer, Bucchiarone et al., "*Using a lifecycle model for developing and executing real-time online applications on clouds*"	Workshop	Springer	2012	Method	University of Muenster, Germany	Case study and experiment
[S71]	Varia, J., "*Migrating Your Existing Application to the AWS Cloud. A Phase-Driven Approach to Cloud Migration*"	White paper	Amazon	2010	Method	Amazon, USA	Experience
[S72]	Wu, J., et al., "*Migrating a Digital Library to a Private Cloud*"	Conference	-	2014	Approach	Information Sciences and Technology Computer	Simulation

						Science and Engineering Pennsylvania State University, USA	
[S73]	Betts,D., Homer, A., Jezierski, A., Narumoto, M., Zhang, H., "*Moving Applications to the Cloud on Microsoft Windows Azure*"	Book	Microsoft	2012	Approach	Microsoft, USA	Experience
[S74]	Maenhaut, p., Moens, H., Ongenae, V., Turck, F "*Migrating legacy software to the cloud: approach and verification by means of two medical software use cases*"	Journal	Wiley Online Library	2015	Method	Ghent University, Belgium	2 Case Studies
[S75]	Kwok, T., "*A Software as a Service with Multi-tenancy Support for an Electronic Contract Management Application*"	Conference	IEEE	2008	Experience	IBM Research Division, Thomas J.Watson Research Center	Experience

* Type of the identified research papers: (i) *methods* defining a process model for migrating applications to the cloud environments, (ii) *general approaches/frameworks* suggesting a solution for a specific phase of cloud migration (e.g. implementation, design, or deployment phases) rather than providing an end-to-end lifecycle, (iii) *industrial experiences* reporting an important development method fragment needed to be taken into account for the cloud migration, (iv) *patterns* proposing reusable practical solutions to resolve repetitive problems in developing cloud applications, and (v) *decision making framework* offering advice on adoption the cloud technology.

Appendix B

Overview of key concerns in the cloud migration process that have been used as yardstick for identifying framework method fragments from the literature

#	Concern	Definition		
C1	Analysing Organisational Context	Assessing the feasibility and business value of the cloud to empower legacy applications in terms of in terms of user resistance, loss of governance, dependency on legacy application, risk of unauthorised access, legal restriction, physical location of IT resources, energy consumption, variation on responsibilities, technical suitability, impact on organisational and daily activities, type of legacy application , required efforts and migration cost , scalability (workload fluctuation), and financial suitability.		
C2	Understanding Cloud Migration Objectives and Requirements	Analysing cloud migration goals and application requirements that should be satisfied by cloud services.		
C3	Proper Cloud Migration Planning	Defining a plan to guide the migration process and roll-back plan.		
C4	Understanding Legacy Application	Identifying the characteristics of legacy application that may influence cloud migration such different types of dependencies to other applications, interaction points and message follows between application components, as well as the quality of code blocks for reuse and adaptation.		
C5	Target Cloud Platform/Service Selection	Analysing available cloud services, their offered model, and their influence on platforms on the required effort for the rest of migration process. Also, training developers on new programming concepts such as asynchronous interaction, distributed state and session management, caching, scale out across data centers and providers (scalability), multi-tenancy.		
C6	Re-Architecting Legacy Applications	C6.1. Defining Cloud Architecture Model		Identifying suitable legacy application components for migration and their deployment (topology) in the cloud with respect to data privacy, expected workload profile, acceptable network latency and performance variability, availability zone of cloud providers, the affinity of components in the cloud, and the geographical location of cloud servers.
		C6.2 Enabling Application Elasticity		Defining elasticity rules and mechanisms in the application in order to support dynamic scale up/down and acquire and release cloud resources in a adequately manner.
		C6.3 Enabling Multi-Tenancy	C6.3.1 Security Isolation	Addressing tenant isolation with respect to the security (i.e. assuring each tenant can only access to its data and to be protected from unauthorised access by other tenants which are running in the same cloud), customisability (adding configuration points, in the form of application template, in the code blocks of the application so that each tenant can customise the sequence of application workflow and code customisation on basis of his/her requirements), fault (monitoring the application state to detect the faults, preventing their propagation, and repairing them in a timely manner), and performance (guaranteeing the performance of one tenant from the negatively being affected by the performance usage of other tenants in unforeseen behaviours).
			C6.3.2 Tenant-Based Application Customisation	
			C6.3.3 Fault Isolation	
			C6.3.4 Performance Isolation	
		C6.4 Addressing Interoperability and Incompatibility	C6.4.1 Code refactoring	Modifying legacy codes so that they can interact with the cloud services.
			C6.4.2 Developing Integrators/Adaptors	Wrapping incompatibilities between legacy and cloud services by using adaptors.
			C6.4.3 Data Adaptation	Resolving incompatibilities between legacy data base and cloud solution database through data type conversions, query transformation, database schema transformation, and developing runtime emulators for stored procedure, views or triggers.

		C6.5 Applying Architecture Design Principles	C6.5.1 Application Decoupling	Re-architecting a legacy application to target cloud architecture with respect to design principles such as application decoupling, stateless programming, handling transient faults, and availability.
			C6.5.2 Stateless Programming	
			C6.5.3 Handling the Unpredictability of Cloud Environments	
			C6.5.4 Replicating and Synchronising	
C7	Environment Configuration	Reconfiguring organisation network setting such as ports, devices, firewalls, and anti-virus, reachability policies, and connection strings to the database so that legacy components can invoke cloud services, giving privileges to application tenants/users to assure the security of application is satisfied in the cloud environment, creating installation scripts and setup different third-party libraries and tools that may be used for monitoring and reporting runtime application behaviour.		
C8	Testing	Ensuring that the migrated application satisfies cloud migration objectives/requirements.		

List of resulting method fragments as the output of the metamodeling				
Harmonized method fragments		**Extracted method fragments relevant to concern**	**Source ID**	**Originated concern**
Analyse Context	Analyse Migration Feasibility	Assessment*	[S22]	C1
		Assessment*	[S25]	
		Business Feasibility Analysis	[S64]	
		Cloud Assessment	[S71]	
		Determine Cloud Readiness	[S8]	
		Establishing the Context	[S3]	
		Evaluate	[S66]	
		Feasibility Study	[S27]	
		Feasibility Study	[S68]	
		Investigate	[S67]	
		Requirements and Feasibility	[S54]	
		Technology Suitability Analysis	[S7]	
		Define Organisation Profile	[S2]	
		Evaluate Organisational Constraints	[S2]	
	Analyse Migration Cost	Migration Effort Estimate	[S25]	C1
		Cost Analysis	[S29]	
		Cost of Migration and Operation	[S65]	
		Effort Estimation	[S68]	
		Migration Cost	[S74]	
		Migration Cost Estimation	[S31]	
	Analyse Organisational Changes	Identifying Change Consequences on the Context*	[S5]	C1
		Organisational Change	[S68]	
		Organisational Change	[S7]	

	Analyse Stakeholder Change	Identifying Change Consequences on the Context*	[S5]	C1
		Identifying Changes	[S5]	
		Stakeholder Impact Analysis	[S5]	
		Stakeholder Impact Analysis	[S7]	
	Analyse Network Change	Determining Impact on Client Network	[S74]	C1
Analyse Migration Requirements	Analyse Technical Requirements	Architecture Requirements	[S48]	C2
		Compute Requirements	[S56]	
		Conducting Requirement Workshops	[S62]	
		Define Requirements	[S30]	
		Early Requirement Engineering and Design	[S70]	
		IT Resource Requirement for the Migration Project	[S25]	
		Managing Non-Functional and QoS Requirements in the Cloud	[S3]	
		Requirement Analysis	[S27]	
		Requirement Analysis	[S68]	
		Requirement Collection	[S22]	
		Requirement Gathering	[S69]	
		Requirements Analysis for Architecture Decisions	[S50]	
		Requirements and Feasibility Activity Area	[S1]	
		Requirements Phase	[S33]	
		System Requirements	[S72]	
		Security Analysis	[S68]	
		Gather Technical Discovery Data	[S29]	
	Analyse Business Requirements	Requirements Identification	[S9]	C2
		Requirements Identification	[S50]	
		Investigate	[S4]	
		Investigate	[S57]	
		Business Analysis	[S51]	
Encrypt Entities	Encrypt Database	Encrypt the Data	[S41]	C2
		Encrypted Data	[S65]	
		Encryption of Data	[S42]	
		Data Protection	[S24]	
		Data Protection	[S63]	
		Encrypted Storage	[S46]	
		Run Over Encrypted Data	[S43]	
	Encrypt/Decrypt Messages	Encrypted Communications	[S65]	C2
		Encrypted Communications	[S73]	
		Message Level Security	[S46]	
		Protect Data in Transit	[S41]	
		Secure Communication Exchange*	[S46]	
	Obfuscate Code	Obfuscated processes	[S40]	C2
	Refactor Codes	Adaptation	[S61]	C6.4.1

Resolve Incompatibilities		Adaptation	[S14]	
		Architectural Change Implementation	[S27]	
		Architecture Adaptation	[S68]	
		Code Modification	[S6]	
		Code Modification	[S68]	
		Gradually Refactor Code	[S32]	
		Implementation	[S9]	
		Implementation and Refactoring	[S9]	
		Modernising Components	[S54]	
		Refactor Application Architecture	[S10]	
		Refactor Application Architecture	[S11]	
		Refactor Application Architecture	[S26]	
		Web Service-Based Invocation of legacy Functionalities	[S13]	
		Modified Architecture	[S50]	
		Provider Incompatibilities*	[S65]	
	Develop Integrators	Adapter Generation and Injection	[S15]	C6.4.2
		Backward Compatibility & Extensibility	[S38]	
		Emulator	[S65]	
		Adopt a Flexible Integration Model	[S29]	
		Implement Integrations	[S29]	
		Integrate services	[S8]	
		Integrating with On-Premises Services	[S73]	
		Integration	[S59]	
		Integration with Legacy Applications	[S39]	
		Interoperability Activity Area	[S1]	
		Runtime Adaptor	[S44]	
		Service Adapters	[S18]	
		Systems Integrator	[S51]	
		On-premise and Off-premise Support	[S38]	
		Web Service Deployment in the Service Cloud	[S13]	
		Transparent Data Access	[S38]	
		Transparent Integration	[S65]	
		Determine Integrations	[S29]	
		Web service generation	[S13]	
	Adapt Data	Solving Mismatches	[S15]	C6.4.3
		BLOB Storage Adaption	[S15]	
		Map	[S22]	
		Compatibility Checking	[S31]	
		Data Store Functionality Extension	[S65]	
		Database Schema Layout	[S25]	
		Migrate	[S6]	

		Migration Data	[S26]	
		Implement Data Migration	[S24]	
		Migrate Data*	[S10]	
Enable Multi-Tenancy	Isolate Tenant Data	Database Transformation	[S58]	C6.3
		Access Control and Isolation	[S40]	
		Adding Tenant Configuration Database	[S74]	
		Authentication	[S35]	
		Database	[S35]	
		Mitigating Security Risks	[S74]	
		Multi-Tenancy	[S39]	
		Security	[S39]	
		Security	[S38]	
		Security Isolation	[S36]	
		Tenant Identification	[S75]	
		Tenant Isolation	[S65]	
		Tenant Management	[S58]	
		Tenant-Based Identification	[S38]	
	Isolate Tenant Performance	Efficient Multi-tenancy	[S43]	
		Performance Isolation	[S36]	
		Performance Isolation	[S38]	
		Performance Isolation and Scalability	[S32]	
	Isolate Tenant Availability	Availability Isolation	[S32]	
		Availability Isolation	[S36]	
	Enable Application Customisation	Allowing Users to Customise Business	[S40]	
		Application Variability	[S45]	
		Configuration	[S35]	
		Configuration and Customisation	[S52]	
		Customisation	[S63]	
		Customisable Interfaces	[S38]	
		Domain Analysis	[S69]	
		Dynamic Feature Selection	[S74]	
		Easy Customisation	[S39]	
		Isolation	[S28]	
		Managing Tenant Data, Users, and Roles	[S74]	
		Multi-Tenancy	[S68]	
		On-the-Fly Customisation	[S36]	
		On-the-Fly Customisation	[S32]	
		Providing Tenant Configuration Interface	[S74]	
		Tenant Customisation	[S75]	
Test Application	Test Designed Architecture	Evaluation	[S14]	C8
		Evaluation	[S60]	

		Evaluation	[S61]	
	Test Application	Test	[S68]	
		Test and Production Environments	[S73]	
		Testing and Monitoring	[S24]	
		Testing Requirements	[S56]	
		Testing	[S6]	
		Testing	[S25]	
		Testing	[S55]	
		Testing	[S69]	
		Validate	[S54]	
		Validate Phase	[S33]	
		Application Migration Plan and Tests*	[S48]	
		Update Documentation	[S29]	
	Test Performance	Final Testing and Go-Live	[S62]	
		Migration Platform Performance Testing	[S58]	
		Optimisation	[S25]	
		Test	[S22]	
		Testing	[S50]	
		Verification and Validation in the Cloud	[S3]	
	Test Interoperability	Heterogeneous Test Environment	[S18]	
		Test	[S72]	
	Test Multi-Tenancy	Tenant Data Isolation Test	[S58]	
	Test Scalability	Verifying the Scalability of Applications	[S3]	
	Test Security	Secure Communication Exchange*	[S46]	
		Migrating Reachability Policies	[S20]	
		Validation Activity Area	[S1]	
		Test Network and Server Connectivity*	[S29]	

Appendix C

Table C1. Experts' feedback about MLSAC regarding quality factors

Design Principles	Question	Experts	Answer
Semantic quality	Q1. The repository provides all important and relevant tasks and work-product that are required for constructing cloud migration methods.	E1	The repository provides major generic tasks and it's fully customisable so it can be extended easily based on project needs.
		E2	An advantage of the prototype is its extensibility and customisability for different needs.
	Q1. The classification of the constructs into the defined phases to represent cloud migration process is appropriate.	E1	Yes
		E2	Yes
	Q2. The classification of constructs based on the migration types is correct.	E1	Yes
		E2	Yes, the flexibility of the framework allows modifying the classification of the constructs.
Pragmatic quality	Q1. Names and definitions that have been used in the forms and constructs help you in tailoring bespoke methods.	E1	Name and definitions are generic and easily to follow but user interface/user experience can be enhanced but the current version is understandable enough for a technical lead to finish tailoring process.
		E2	Yes
	Q2. Steps to define bespoke migration methods are clear and easy to follow.	E1	Yes because the prototype provides customisation support if required.
		E2	A migration method for hybrid migration (for example selecting type I and type V) cannot be easy defined by the prototype. As such a user needs to choose a migration type which is conceptually similar to the migration type.
	Q3. Visualisation in MLSAC (e.g. Tree-view structure as a mean for method visualisation) is understandable and helpful for organising methods.	E1	Tree-view is easy to understand and helps to come up with an organised structure of the plan but the order and relation of tasks are not very intuitive. It would be nice if I could change the order of tasks easier (e.g. drag and drop). I also noticed that the newly defined task or subtasks are always appended to the end of the corresponding branch and it is not currently possible to change the order.
		E2	It would be good if the visualisation was able to show *iterative development*. This notion could be realised by showing a simple icon in the tasks.
Tailorability quality	Q1. MLSAC provides a good support to incorporate necessary parameters required for method tailoring.	E1	It would be nice if the user could have access to a list of suggestive tasks classified under different domains like (Mobile cloud etc.)
		E2	As mentioned, a hybrid migration is hard to support by the current prototype. As such user needs to choose a migration type which is conceptually similar to the migration type.
	Q3. The defined steps in MLSAC are easy to use for method creation, configuration, maintenance, and sharing.	E1	I would like to have a "share with email option" instead of exporting and attaching an XML file separately. Also, it would be very nice if I could configure to share the database of MLSAC and export data in cloud spaces used by everyone who needs to be exposed to the generated data.

		E2	Yes, but a Web-based version of the prototype could be more efficacious.
	Q4. MLSAC reduces efforts for method tailoring.	E1	Yes, but there is a lack of support for reusable templates to be used as a starting point based on different architecture design styles which can lead to better efficiency by saving time and increasing user satisfaction.
		E2	Yes, but it would be great if the prototype could support pre-defined templates for different legacy system types such as finance, insurance, and e-commerce.
	Q5. MLSAC provides a suitable environment for method tailoring in a given migration scenario.	E1	Certainly there is a room for improvement but the main features are there.
		E2	Yes, in comparison with other existing tools like Microsoft Project, this prototype provides a pre-built rich repository of important items required for creating migration strategies. This feature protects users of missing some important considerations for cloud migration.
	Q6. MLSAC facilitates systematic reuse in designing of bespoke cloud migration methods.	E1	Yes.
		E2	Yes. The pre built-in repository is helpful.
	Q7. MLSAC is useful for sharing cloud migration methods among development teams.	E1	Yes.
		E2	As a suggestion, it would be good if the prototype could be Web-based with a support for multiple user support. Users could simultaneously work on the method and share it. With the current version of the prototype, there is a need to multiple saves and restores the XML file of a method which may cause inconsistency of the method content. Furthermore, it would be good if the prototype would be able to keep track of method changes such as adding, removing, modifying tasks during the method lifetime.
Final Question	Please comment on how to improve The repository in reflection to missing constructs, if any.	E1	Due to the fact that the repository is fully customisable, I believe it does provide all necessary components and I can't think about a major improvement.
		E2	The constructs are complete.
	Describe the usefulness of MLSAC for its audiences. In what ways do you think MLSAC would create value to the audience? Please explain why.	- E1	In conclusion, the prototype is simple and easy to use to the point of meeting major objectives of a method customisation process, but it could be further enhanced to include more features and more professional look and feel.
		E2	The prototype system saves time for creating migration strategy by proving a pre built-in repository. Visualisation instead of documentation helps to a better understanding the process. XML output can be integrated with other tracking and visualisation systems.
Definitions *Semantic quality*: we mean that the prototype captures all important constructs (phases, tasks, and work-products) that are relevant for the incorporation into a typical process of legacy migration to the cloud. Also, we mean that the prototype should define valid relationships between constructs as well as construct names, appropriate notational syntax, and the classification of constructs.			

Pragmatic quality: we mean the clarity and meaningfulness of constructs in MLSAC for its audiences such as process/method engineers, project managers, or software developers who are closely involved in a scenario of legacy to cloud migration.
Tailorability quality: we mean that the prototype provides a suitable environment for efficient method creation and configuration regarding a cloud migration scenario at hand.

Appendix D

Relationships among the method fragments in MLSAC derived from either literature source or metamodeling iterations (literature source see Appendix A)

Relationship Type	Relationship Name	Method fragment 1		Method fragment 2		Source
		Name	Type	Name	Type	
Association	Uses	Choose Cloud Provider	Task	Analyse Migration Requirements	Task	[S9]
Association	Uses	Design Cloud Solution	Task	Plan Migration	Task	[S10], [S29], [S24]
Association	Uses	Design Cloud Solution	Task	Analyse Migration Requirements	Task	[S32]
Association	Uses	Design Cloud Solution	Task	Identify Incompatibilities	Task	[S10]
Association	Uses	Design Cloud Solution	Task	Choose Cloud Provider	Task	[S10]
Association	Use	Refactor Codes	Task	Identify Incompatibilities	Task	[S10],[S65]
Association	Uses	Design Cloud Solution	Task	Recover Legacy Application Knowledge	Task	[S13]
Association	Uses	Refactor Codes	Task	Design Cloud Solution	Task	[S6],[S9],[S22]
Association	Uses	Design Cloud Solution	Task	Recover Legacy Application Knowledge	Task	[S22]
Association	Uses	Test Application	Task	Design Cloud Solution	Task	[S24]
Association	Uses	Plan Migration	Task	Analyse Context	Task	[S24]
Association	Uses	Plan Migration	Task	Recover Legacy Application Knowledge	Task	[S22], [S27]
Association	Produces	Plan Migration	Task	Migration Plan	Work-Product	[S1],[S3],[S4], [S9],[S22],[S25], [S27],[S30],[S48], [S48],[S50],[S50], [S51],[S54],[S56], [S6],[S62],[S68],[S68],[S69],[S70],[S72]
Association	Produces	Analyse Migration Requirements	Task	Migration Requirements	Work-Product	[S1],[S3],[S4],[S9] ,[S22],[S25],[S27] ,[S30],[S48], [S48],[S50],[S50], [S51],[S54],[S56], [S62],[S62],[S68], [S68],[S69],[S70], [S72]
Association	Produces	Recover Legacy Application Knowledge	Task	Legacy Application Model	Work-Product	[S1],[S2],[S12],[S 13],[S14],[S22],[S 25],[S27],[S29],[S 32],[S33],[S37],[S

						48],[S48],[S54],[S64],[S56],[S57] [S59],[S60],[S61], [S62],[S64],[S65], [S66],[S68],[S70] [S72]
Association	Produces	Design Cloud Solution	Task	Virtual Machin Specifications	Work-Product	[S12],[S65]
Association	Produces	Design Cloud Solution	Task	Cloud Solution Architecture Model	Work-Product	[S9],[S12],[S65]
Association	Produces	Enable Application Customisation	Task	Application Templates	Work-Product	[S35], [S56]
Association	Follows	Resolve Incompatibilities	Task	Test	Task	[S6],[S25]
Association	Follows	Plan Migration	Phase	Design Phase	Phase	[S68]
Association	Follows	Design Phase	Phase	Enable Phase	Phase	[S68]
Association	Follows	Choose Cloud Provider	Task	Identify Incompatibilities	Task	[S6], [S9], [S65]
Association	Follows	Adapt Data	Task	Refactor Codes	Task	[S10]
Aggregation	isAGroupOf	Recover Legacy Application Knowledge	Task	Plan	Phase	Metamodeling iteration
Aggregation	isAGroupOf	Analyse Migration Requirements	Task	Plan	Phase	Metamodeling iteration
Aggregation	isAGroupOf	Analyse Context	Task	Plan	Phase	Metamodeling iteration
Aggregation	isAGroupOf	Plan Migration	Task	Plan	Phase	Metamodeling iteration
Aggregation	isAGroupOf	Resolve Incompatibilities	Task	Enable	Phase	Metamodeling iteration
Aggregation	isAGroupOf	Configure Network	Task	Enable	Phase	Metamodeling iteration
Aggregation	isAGroupOf	Deploy Application Components	Task	Enable	Phase	Metamodeling iteration
Aggregation	isAGroupOf	Rebalance Application	Task	Enable	Phase	Metamodeling iteration
Aggregation	isAGroupOf	Test	Task	Enable	Phase	Metamodeling iteration
Aggregation	isAGroupOf	Encrypt/Decrypt Entities	Task	Enable	Phase	Metamodeling iteration
Aggregation	isAGroupOf	Plan Migration	Task	Plan	Phase	Metamodeling iteration
Aggregation	isAGroupOf	Design Cloud Solution	Task	Design	Phase	Metamodeling iteration
Aggregation	isAGroupOf	Isolate Tenant	Task	Enable	Phase	Metamodeling iteration
Aggregation	isAGroupOf	Configure Network	Task	Enable	Phase	Metamodeling iteration
Aggregation	isAGroupOf	Enable Elasticity	Task	Enable	Phase	Metamodeling iteration

Aggregation	isAGroupOf	Make Application Stateless	Principle	Apply Design Principles	Principle	[S6], [S24]
Aggregation	isAGroupOf	Decouple Application Components	Principle	Apply Design Principles	Principle	[S6], [S25]
Aggregation	isAGroupOf	Handle Transient Faults	Principle	Apply Design Principles	Principle	[S73], [S65]
Aggregation	isAGroupOf	Replicate Application Components	Principle	Apply Design Principles	Principle	[S65]
Aggregation	isAGroupOf	Synchronise Application Components	Principle	Apply Design Principles	Principle	[S65]
Specialisation	isAKindOf	Analyse Organisational Changes	Task	Analyse Context	Task	Metamodeling iteration
Specialisation	isAKindOf	Analyse Stakeholder Changes	Task	Analyse Context	Task	Metamodeling iteration
Specialisation	isAKindOf	Analyse Network Changes	Task	Analyse Context	Task	Metamodeling iteration
Specialisation	isAKindOf	Analyse Migration Feasibility	Task	Analyse Context	Task	Metamodeling iteration
Specialisation	isAKindOf	Analyse Migration Cost	Task	Analyse Context	Task	Metamodeling iteration
Specialisation	isAKindOf	Analyse Technical Requirements	Task	Analyse Migration Requirements	Task	Metamodeling iteration
Specialisation	isAKindOf	Analyse Business Requirements	Task	Analyse Migration Requirements	Task	Metamodeling iteration
Specialisation	isAKindOf	Isolate Tenants Data	Task	Isolate Tenants	Task	[S6], [S35]
Specialisation	isAKindOf	Isolate Tenants Performance	Task	Isolate Tenants	Task	[S6], [S35]
Specialisation	isAKindOf	Isolate Tenants Availability	Task	Isolate Tenants	Task	[S6], [S35]
Specialisation	isAKindOf	Isolate Tenants Customisation	Task	Isolate Tenants	Task	[S6], [S35]
Specialisation	isAKindOf	Encrypt Database	Task	Encrypt/Decrypt Entities	Task	Metamodeling iteration
Specialisation	isAKindOf	Obfuscate Codes	Task	Encrypt/Decrypt Entities	Task	Metamodeling iteration
Specialisation	isAKindOf	Encrypt/Decrypt Messages	Task	Encrypt/Decrypt Entities	Task	Metamodeling iteration
Specialisation	isAKindOf	Re-factor Codes	Task	Resolve Incompatibilities	Task	Metamodeling iteration
Specialisation	isAKindOf	Develop Integrators	Task	Resolve Incompatibilities	Task	Metamodeling iteration
Specialisation	isAKindOf	Migrate Data	Task	Resolve Incompatibilities	Task	Metamodeling iteration

Specialisation	isAKindOf	Test Network Connectivity	Task	Test Application	Task	Metamodeling iteration
Specialisation	isAKindOf	Test Scalability	Task	Test Design Architecture	Task	Metamodeling iteration
Specialisation	isAKindOf	Test Multi-Tenancy	Task	Test Design Architecture	Task	Metamodeling iteration
Specialisation	isAKindOf	Test Security	Task	Test Design Architecture	Task	Metamodeling iteration
Specialisation	isAKindOf	Test Performance	Task	Test Design Architecture	Task	Metamodeling iteration
Specialisation	isAKindOf	Test Interoperability	Task	Test Design Architecture	Task	Metamodeling iteration
Specialisation	isAKindOf	Test Designed Architecture	Task	Test Application	Task	Metamodeling iteration