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DATA EXTRACTION FORM

Collaborative Model-Driven Software Engineering

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ABSTRACT

This document describes the parameters of the data extraction activity of a systematic mapping study on collaborative model-driven software engineering.

DOCUMENT VERSION CONTROL

Document status	**Version**	**Date**	**Changes from previous version**
Draft	0.1	October 13, 2015	None
Revised	0.2	October 14, 2015	Added the majority of parameters
Revised and completed	0.5	January 22, 2016	Completed and revised all the parameters

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ID	Attribute name	Type	Values set (if single/multiple type)	Increm. set	Description
GEN-1	ID	Single	see Table 7		Unique identifier of the study across all the primary studies.
GEN-2	Title	Open			Title of the primary study as it appears in the downloaded paper
GEN-3	Mnemonic name	Open			The name of the study/tool/approach (if any) directly proposed by the authors
GEN-4	Authors	Open			List of the authors of the primary study.
GEN-5	Institutions	Open			List of the institutions of the primary study (as defined in the article itself).
GEN-6	Page count	Open			Number of pages of the main study
GEN-7	Reviewer	Multiple	{Franzago, DiRuscio, Malavolta, Muccini}		The names of those who extracted the data for the current study
	Search strategy informations				
SSI-1	Additional papers	Open		✓	The name of the folder containing all the papers used for the data extraction of the primary study.
SSI-2	Search method	Single	{A, S, P}		The search method that the researcher used for obtaining the study. {A = Automatic, S = Snowballing, P = Pilot}
SSI-3	Source	Single	see Table 2 $\cup$ {other}		The name of the electronic database from which the study has been searched, {other} if the study is coming from an electronic database not included in Table 2.
SSI-4	Main study	Open			If the paper is coming from the snowballing activity, then this parameter represents which paper this primary study is coming from (either backward or forward).
SSI-5	Snowball activity	Single	{F, B}		If the paper is coming from the snowballing activity, then this parameter represents in which kind of snowballing the paper has been included in our study. {F = Forward, B = Backward}

RQ1.1	**Model management**				
MM-1	Artifact type	Multiple choice	{M, MM}		The level of the artifacts under collaboration, based on the Four-layered metamodeling stack, see [1, fig. 7.2].
MM-2	Concrete syntax type	Multiple choice	{No, TEX, GRA, SKE, TREE, TAB, External}	✓	Type of editor provided by the approach for models editing { No = NoEditor, TEX = Textual, GRA = Graphical, SKE = Sketch-based, TREE = tree-view, TAB = tabular (e.g. a matrix-view to setup model element attributes), External = the approach prescribed an external editor for model editing or an external editor that needs an adapter to be integrated in the approach}
MM-3	Editor type	Multiple choice	{No, Web, Desktop}		If the approach provides a tool support (client-side) {No = NoSupport, Web = web-based, Desktop = desktop-based}
MM-4	Multi-views	Multiple choice	{Syn, Proj, No}		Support for multi-view modeling: the approach provides support for multi-view modeling based on an arbitrary number of custom views defined on top of one or more underlying modeling language(s). {Syn = Synthetic, Proj = Projective, No = NoMultiViewSupport} [2]
MM-5	Modeling language	Multiple choice	see Table 3	✓	If the approach is tailored to support collaboration modeling with some specific language(s) or it provides some mechanism to import/define user-defined languages.
MM-7	Application domain	Single choice	{Generic, Specific, Hybrid}		Is the approach suitable to specific type of systems or suitable to generic type of systems?
MM-8	Application domain type	Multiple choice	{Generic, Large-scale information systems, Mobile Applications, Web Applications, Business Applications, ITsystems}	✓	If System domain is not generic, what is the domain of application?

MM-9	System parts	Multiple choice	{Generic, UI, Data, Business Logic, Navigation, others}	✓	Is the proposed approach specific for one or more predefined parts of the system?
MM-10	Language(s) customization	Single choice	see Table 4		Mechanisms to import/define/adapt underlying modeling language(s) to some specific concepts not originally supported.
MM-11	Validation support	Single choice	{No, rules, OCL, constraints, Critics}	✓	If the approach provides some kind of validation support, over the simply conformance.
MM-12	Reuse granularity	Multiple choice	{Model, Frag, Pack, No}	✓	Which kind of (cross-models) reuse support does the approach provide? {Model = whole model, Frag = model fragment, Pack = multiple models (project/package), No = No support}
RQ1.2	**Collaboration support**				
COLL-1	Collaboration type	Multiple choice	{Synch, Async}		Type of users interaction in terms of modeling operations distribution in the time space [3]: {Synch = real-time interaction, if it is possible for two or more users work ”collaboratively” on the same artifact at the same time in a (near) real-time fashion, Async = user can not see in real-time other users operations, they must perform an update/checkout action}
COLL-2	Workspace location	Multiple choice	{Local, Remote}		Type of collaboration in term of users distribution spatially {Local = users face-to-face co-located in the same room, Remote = users ”behind” a remote device, can collaborate/communicate only by software tools }
COLL-3	Roles	Multiple choice	see Table 6	✓	Does the approach characterize the involved actors in the collaboration process by roles?

COLL-4	Versioning support	Single choice	{NoSupport, Generic, Models, Wiki, Adhoc}	✓	If the approach provides a versioning mechanism to keep trace of the artifact versions during the evolution. {Generic = file/text-based versioning, Models = the approach uses an existing models version system, Wiki = the approach keeps versions using a wiki engine, Adhoc = the approach uses an adhoc models version system }
COLL-5	Version Control System (VCS) architecture	Single choice	{Centralized, Distributed}		Centralized = the VCS has a single server that contains all the versioned files, and a number of clients that check out files from that central place, Distributed = clients dont just check out the latest snapshot of the files: they fully mirror the repository (versioning also "in local"). For more details, see [4].
COLL-6	Branching support	Single choice	{Yes, No}		Branching means you diverge from the main line of development and continue to do work without messing with that main line.
COLL-7	Model merging support	Single choice	{Yes, No}		Support for merging of two or more different artifact versions or branches.
COLL-8	Conflict detection support	Single choice	{Yes, No, Av}		Support for conflict detection: a conflict appears when two users perform two conflicting operations (or two sets of conflicting operations), e.g. one user changes an object name and another user deletes the same object {av = avoided (e.g.using locking,using FIFO schedule,etc..), no conflicts detection support}
COLL-9	Conflict resolution type	Multiple choice	{NoSupport, Manual, Automatic, Mixed}		Conflict resolution support provided by the approach.
COLL-10	Collaboration workflow	Single choice	{Yes, No, Part}		The study prescribes a collaboration workflow (i.e. sequence of steps). {Part = partially described}
COLL-11	Network architecture	Single choice	{Star with central server, P2P, Mixed}	✓	P2P = collaboration without a central server (clients communicates directly each other), Mixed = clients exchange messages/editing operations directly each other, but there is a central server (e.g.used as common repository).

RQ1.3	**Communication support**				
COM-9	Stakeholder types	Multiple choice	{Techn, NonTech}		Which type of involved stakeholders collaborate thought the approach? {Techn = technical, NonTech = also non technical }
COM-10	Approach-specific stakeholders	Multiple choice	{developer, functional analyst, usability expert, domain expert, business process expert, modeling expert, end user, customer, information architect, UI designer, app developer, back-end developer, content producer, project manager, software architect, software engineer, business process stakeholder, domain expert, model engineer, business analyst}	✓	Approaches that are dedicated to specific types of stakeholders.
COM-1	Workspace awareness tools	Multiple choice	see Table 5	✓	Awareness support to other users operations while they are working on the same artifact/project .
COM-2	Workspace awareness level	Single choice	{Low, Med, High}		Scoring related to *who*, *what* and *where* is doing some operation on some artifacts inside the workspace [5, Tab.I]. Each of the three categories (who,what,where) counts 1. The level is calculated as who + what + where. {0-1 = Low, 2 = Med, 3 = High}
COM-3	Communication tools: builtin	Multiple choice	{Annotations, Comments, Tags, Reviews, Chat, CallForAttention, StickyNotes, Proposals, Audio, ConflictsTable, Voting, Feedback, Forum}	✓	Communication means provided by the approach, integrated in it.

COM-4	Communication tools: external	Multiple choice	{Voice, HandGestures, Avtool, Email, ExternalChat, Face-to-face, Hyperlinks, Wiki, MultimediaAnnotations}	✓	Communication means prescribed by the approach, external to it; or communication means provided by the approach as a internal link through external resources (e.g. hyperlinks, links to other external documents, etc...).
COM-6	Traceability links	Multiple choice	Subset of the communication means: {builtin} ∪ {external}		Subset of the communication means that are linked to artifacts/model elements useful, for example, for design decision traceability.
RQ2	**Challenges**				
FN-1	Limitations	Open			Set of fragments of the study in which the authors describe limitations of the proposed approach and challenges that should be addressed, both from the collaborative modeling point of view.
FN-2	Future work	Open			Set of fragments of the study in which the authors describe their future works on collaborative modeling (usually this part of the study is in a dedicated section at the end of the article or in the Conclusions section).
RQ3	**Publication trends**				
PT-1	Keywords	Open			Keywords and/or Index terms of the primary study (indicated by the authors in the article itself).
PT-2	Venue	Open			The acronym of the venue in which the study has been published (e.g., ICSE, ASE, FASE, MODELS, etc.).
PT-3	Venue (complete name)	Open			The complete name of the venue in which the study has been published.
PT-4	Year	Open			The year of publication of the study.
PT-5	Publisher	Open			The publisher of the study (e.g., IEEE, ACM, etc.).
PT-6	Publication type	Single	{C, J, B, W, M}		The type of publication venue in which the study has been published. {C = Conference, J = Journal, B = Book chapter, W = Workshop, M = Magazine}
PT-7	Citations	Open			Citations' number of the main paper of the study (took from Google Scholar)

Library	Website
IEEE Digital Library	ieeexplore.ieee.org
ACM Digital Library	dl.acm.org
SpringerLink	link.springer.com
ScienceDirect	sciencedirect.com
Wiley Online Library	onlinelibrary.wiley.com
Web of Science	webofknowledge.com

Table 2: Electronic data sources targeted with search strings

Values	Description
no	Not language-specific: the approach provides some kind of mechanism to import or define one or more domain language(s)
Ecore	Specific for Ecore language, the core meta-model of the Eclipse Modeling Framework (EMF)
UML	Specific for OMG Unified Modeling Language (or a sub-part of UML)
BPMN	Specific for OMG Business Process Model and Notation (or a sub-part of BPMN)
CFR_MBUI	Specific for Model-Based User Interface Development of Cameleon Reference Framework
JPA	Specific for the Java Persistence API
ER	Specific for the entity-relationship language
Flowchart	Specific for the flowchart language

Table 3: Language-specific attribute

Values	Description
no	The approach does not provide language customization mechanism.
ex	Extension
import	It is possible to import external language(s) or automatically generate the editor starting from a language definition (metamodel)
infer	It is possible to collaborate without knowing a-priori the language, e.g. after the upload of a model instance, the approach can derive automatically the metamodel (for instance through reflective programming techniques)

Table 4: Language customization

Types	Description
VCS	Awareness provided by the versioning system (e.g.commit messages, update notifications, etc...)
UpEd	For real-time collaboration, updates from other users directly in the editor
HSE	Highlighted selected model elements from other users
Lock	Highlighted locked model elements under editing by other users
Wiki	Awareness provided by the wiki engine (e.g.updates log, users active, etc...)
Users	List of the users currently active
Ntf	General notifications (e.g.a popup messages, etc...)
Status	Status area: the user receives general information about the editing operations of other users inside a special area of the client tool (e.g.operations' timestamps)
HCE	Highlighted conflict model elements (e.g.two users made two conflicting editing operations on the same model element)
Dashboard	A dedicated area where user can find information about the project, in particular about other users' activities (not only 'editing activities', e.g.log)
Over	Overview of the model: the user can visually see where other users are working on (which parts of the current model)
Colors	Each user has a personal "color": each action or message from that user, will be highlighted with that color
Whiteboard	A special area of the client tool where the users can make free-hand drawings and sketch something to communicate to others
Pointers	The users can see where other users' mouse pointers are
EmailNotif	The users can receive notifications by email
User_action	The specific action or operation the user is carrying out within the workspace, i.e.a link between an operation and who made that specific operation
ConflictList	A dedicated area with a list of current conflicts to manage

Table 5: Workspace awareness

Roles	Description
Facilitator	this group consists of users that can play a key role in any collaborative modelling session. They are senior users that make decision when needed
(Project) Administrator	users in this group have full access to the artifact being developed including their deletions
(Server) Administrator	this group refer to users that can administer also users further than the projects being developed
Reader	users belonging to such a group can only see developed modelling artifact without having the possibility to operate changes on them
Integrator	some approaches recognizes such a role representing users, which have the responsibility of performing integration activities i.e., merging changes operated by different developers and ask them to review and agree the integrated results
Controller	the controller propagates accepted changes to all members of a given group of users, and changes propagated from the controller are applied on the artifacts stored in the main branch of the considered repository
Editor	users of such group can read and write their local copy of the (meta)models, and can only read those that are in the main branch of the considered repository
Project Leader	in case of conflicting changes, some approaches consider a particular kind of users that can start discussions among modelers aiming at mitigating conflicting changes and resolve them. Project leaders have such a responsibility
Other	Peculiar roles not categorizable into the previous categories
No	No roles, all the modelers are ”pairs” during the collaboration activities

Table 6: Collaboration roles list

ID	Title	Author	Venue	Year
P1	A Model Repository for Collaborative Modeling with the Jazz Development Platform	Bartelt C., Molter G.,Schumann T.	Hawaii International Conference on System Sciences	2009
P2	FLEXISKETCH TEAM- Collaborative Sketching and Notation Creation on the Fly	Dustin Wuest,Norbert Seyff,Martin Glinz	International Conference on Software Engineering	2015
P3	A World-Wide-Web Architecture for Collaborative Software Design	Nicholas Graham,Hugh D. Stewart,Reza Kopaee,Arthur G. Ryman,Rittu Rasouli	Software Technology and Engineering Practice	1999
P4	AME: an Adaptive Modelling Environment as a Collaborative Modelling Tool	Alfonso Garcia Frey,Jean-Sebastien Sottet,Alain Vagner	Engineering interactive computing systems	2014
P5	Collaborative Software Engineering on Large-scale models: Requirements and Experience in ModelBus	Prawee Sriplakich,Xavier Blanc,Marie-Pierre Gervais	Applied Computing Pages	2008
P6	A case-study of wiki-supported collaborative drafting of business processes models	Selim Erol, Gustaf Neumann	International Conference on Business Informatics	2013
P7	GenMyModel : An Online UML Case Tool	Michel Dirix,Alexis Muller,Vincent Aranega	European Conferences on Object-Oriented Programming	2013
P8	Design Management: A Collaborative Design Solution	Maged Elaasar, James Conallen	European Conference on Modelling Foundations and Applications	2013
P9	CAMEL: A Tool for Collaborative Distributed Software Design	Marcelo Cataldo,Charles Shelton,Yongjoon Choi,Yun-Yin Huang,Vytesh Ramesh,Darpan Saini,Liang-Yun Wang	International Conference on Global Software Engineering	2009
P10	SLIM - A Lightweight Environment for Synchronous Collaborative Modeling	Christian Thum, Michael Schwind,Martin Schader	Model Driven Engineering Languages and Systems	2009
P11	A Web-Based Collaborative Metamodeling Environment with Secure Remote Model Access	Matthias Farwick,Berthold Agreiter,Jules White,Simon Forster,Norbert Lanzanasto,Ruth Breu	International Conference Web Engineering	2010
P12	Metaedit+ A Fully Configurable Multi-User and Multi-Tool CASE and CAME Environment	Steven Kelly,Kalle Lyytinen,Matti Rossi	International Conference on Advanced Information Systems	1996
P13	Next Generation (Meta)Modeling: Web- and Cloud-based Collaborative Tool Infrastructure	Miklos Maroti,Tamas Kecskes,Robert Kereskenyi,Brian Broll,Peter Volgyesi,Laszlo Juracz,Tihamer Levendoszky,Akos Ledeczi	Multi-Paradigm Modeling	2014
P14	Towards a Collaborative Framework for the Design and Development of Data-Intensive Mobile Applications	Mirco Franzago, Ivano Malavolta, Henry Muccini	International Conference on Mobile Software Engineering and Systems	2014
P15	MUE: Multi User UML Editor	Suhadi Lili, Sutarsa, Siti Rochhimah	Information and Communication Technology Seminar	2005
P16	AToMPM: A Web-based Modeling Environment	Eugene Syriani, Hans Vangheluwe, Raphael Mannadiar, Conner Hansen, Simon Van Mierlo, Huseyin Ergin	Model Driven Engineering Languages and Systems	2013
P17	CoDesign A Highly Extensible Collaborative Software Modeling Framework	Bang Jae Young, Daniel Popescu, George Edwards, Nenad Medvidovic, Naveen Kulkarni, Girish M. Rama, Srinivas Padmanabhuni	International Conference on Software Engineering	2010
P18	Design and Evaluation of a Service Oriented Architecture-based Application to Support the Collaborative Edition of UML Class Diagrams	Penichet V.M.R.,J.A.Gallud,R.Tesoriero,M.Lozano	International Conference on Computational Science	2008
P19	Simplifying the Development of Cross-Platform Web User Interfaces by Collaborative Model-based Design	Vivian Genaro Motti,Dave Raggett,Sascha Van Cauwelaert,Jean Vanderdonckt	Special Interest Group on the Design of Communication	2013
P20	Sysiphus: Enabling informal collaboration in global software development	Bernd Bruegge, Allen H. Dutoit, Timo Wolf	International Conference on Global Software Engineering	2006
P21	Unicase an Ecosystem for Unified Software Engineering Research Tools	Bernd Bruegge, Oliver Creighton, Jonas Helming, Maximilian Kogel	Distributed Software Development - Methods and Tools for Risk Management	2008
P22	We can work it out: Collaborative Conflict Resolution in Model Versioning	Petra Brosch, Martina Seidl,Konrad Wieland, Manuel Wimmer, Philip Langer	European Conference on Computer Supported Cooperative Work	2009
P23	Towards a Framework for Distributed and Collaborative Modeling	Antonio Cicchetti, Henry Muccini, Patrizio Pelliccione, Alfonso Pierantonio	International Workshops on Enabling Technologies: Infrastructures for Collaborative Enterprises	2009
P24	Research of Consistency Maintenance Mechanism in Real-Time Collaborative Multi-View Business Modeling	Hong-ming Cai, Xiao-feng Ji, Feng-lin Bu	Journal of Shanghai Jiaotong University (Science)	2015
P25	Constructing real-time collaborative software engineering tools using CAISE, an architecture for supporting tool development	Carl Cook, Neville Churcher	Australasian Computer Science Conference	2006
P26	Distributed Collaborative Modeling Support System Associating UML Diagrams with Chat Messages	Xu Dongmei, Jun Kurogi, Yoshihide Ohgame, Atsuo Hazeyama	Computer Software and Applications Conference	2009
P27	Group Support for Distributed Collaborative Concurrent Software Modeling	Naoufel Boulila,Bernd Bruegge	International Conference on Automated Software Engineering	2004
P28	Model-based Real-time Synchronization	Stephan Krusche, Bernd Bruegge	Comparison and Versioning of Software Models	2014
P29	A Guide to Map Application Components to Support Multi-User Real-Time Collaboration	Mauro Pichiliani,Celso Hirata	International Conference on Collaborative Computing: Networking, Applications and Worksharing	2006
P30	Collaborative Modeling - A Design Science Approach	Peter Rittgen	Hawaii International Conference on System Sciences	2009
P31	A Collaborative Mobile Approach for Business Process Elicitation	Nelson Baloian, Gustavo Zurita, Flavia Maria Santoro, Renata Mendes Araujo, Sean Wolfgan, Doulgas Machado, Jose A. Pino	International Conference on Computer Supported Cooperative Work in Design	2011
P32	Supporting collaborative learning and problem-solving in a constraint-based CSCL environment for UML class diagrams	Baghaei, Nilufar, Antonija Mitrovic, Warwick Irwin	International Journal of Computer-Supported Collaborative Learning	2007
P33	Collaborative editing of EMF/Ecore meta-models and models: Conflict detection, reconciliation, and merging in DiCoMEF	Amanuel A. Koshima, Vincent Englebert	Science of Computer Programming	2015
P34	Enhancing collaborative synchronous UML modelling with fine-grained versioning of software artefacts	De Lucia,Fasano,Scanniello,Tortora	Journal of Visual Languages and Computing	2007
P35	Scaling Up Model Driven Engineering Experience and Lessons Learnt	Vinay Kulkarni, Sreedhar Reddy, Asha Rajbhoj	Model Driven Engineering Languages and Systems	2010
P36	D-praxis: A peer-to-peer collaborative model editing framework	Mougenot,Blanc,Gervais	Distributed Applications and Interoperable Systems International Conference	2009
P37	A semantically rich approach for collaborative model edition	Michaux, Blanc, Shapiro, Sutra	Applied Computing Pages	2011
P38	Concurrent Fine-grained Versioning of UML Models	De Lucia,Fasano,Scanniello,Tortora	European Conference on Software Maintenance and Reengineering	2009
P39	A model-driven development method for collaborative modeling tools	Jesus Gallardo,Crescencio Bravo,Miguel Redondo	Journal of Network and Computer Applications	2012
P40	Defining Tasks, Domains and Conversational Acts in CSCW Systems: the SPACE-DESIGN Case Study	Duque,Gallardo,Bravo, Mendes	Journal of Universal Computer Science	2008
P41	Pounamu: A meta-tool for exploratory domain-specific visual language tool development	Nianping Zhu, John Grundy, John Hosking, Na Liu, Shuping Cao, Akhil Mehra	Journal of Systems and Software	2007
P42	Odyssey-SCM: An integrated software configuration management infrastructure for UML models	Leonardo Murta, Hamilton Oliveira, Cristine Dantas, Luiz Gustavo Lopes, Claudia Werner	Science of Computer Programming	2007
P43	Building Flexible, Distributed Collaboration Tools using Type-Based Publish/Subscribe - The Distributed Knight Case	Christian Heide Damm,Klaus Marius Hansen	Software Engineering	2004
P44	Collaborative Business Process Modeling	Simon Forster,Jakob Pinggera,Barbara Weber	Enterprise Modelling and Information Systems Architectures	2012
P45	A framework for the collaborative specification of semantically annotated business processes	Chiara Di Francescomarino,Chiara Ghidini,Marco Rospocher,Luciano Serafini,Paolo Tonella	Journal of Software Maintenance and Evolution: Research and Practice	2011
P46	MoVEing Forward: Towards an Architecture and Processes for a Living Models Infrastructure	Michael Breu, Ruth Breu, Sarah Low	International Journal On Advances in Life Sciences	2011
P47	Proactive Detection of Higher-Order Software Design Conflicts	Jae young Bang,Nenad Medvidovic	Working IEEE / IFIP Conference on Software Architecture"	2015
P48	Turning Conflicts into Collaboration	Konrad Wieland,Philip Langer,Martina Seidl,Manuel Wimmer,Gerti Kappel	Computer Supported Cooperative Work (The Journal of Collaborative Computing and Work Practices)	2013

Table 7: List of the selected primary studies

References

[1] M. Brambilla, J. Cabot, M. Wimmer, Model-driven software engineering in practice, Vol. 1, Morgan & Claypool Publishers, 2012.

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