Review Protocol for

"A Systematic Review of the continuous development, deployment, and orchestration for IoT systems"

# Motivation

Internet of Things (IoT) is becoming omnipresent all over the world (cite Gartner). As defined in [] technically, IoT systems are… IoT can also be the game changer in many public and private sectors. The market of IoT is growing quickly and soon will reach ??? billion USD by 2020. The engineering approaches for IoT have been blooming as well. Some examples of IoT applications here.

Therefore, we want to do a systematic review on the software engineering (SE) approaches for the development, deployment, and orchestration of IoT systems.

In the rapid development of both the IoT market and the IoT engineering approaches, modern SE approaches such as Agile, DevOps would be key to ensure the continuous delivery of trustworthy IoT systems. Etc.

Our internal motivation is to do a systematic review of existing relevant approaches in the context of the ENACT project. This systematic review would serve as a key research contribution to the D2.1 and D3.1. In other words, the D2.1 and D3.1 should be able to refer to the content of this systematic review, heavily or lightly, to be seen after getting the results of this review.

***D2.1: Survey and requirements of Risk-driven Continuous Delivery of Trustworthy Smart IoT Systems*** *(M10) (Editor: CNRS) (R, PU)*

*This deliverable will provide an overview of the state-of-the-art mechanisms for the risk-driven continuous delivery of trustworthy SIS. In addition, this deliverable will characterize the requirement, including trustworthiness requirements, to be considered.*

***D3.1 Requirements and conceptual design of techniques and methods for trustworthy & agile operation of smart IoT systems*** *(M10) (Editor: CNRS) (R, PU)*

*This deliverable will provide an overview of the state-of-the-art mechanisms for the operation of IoT systems. In addition, it will characterize the requirement, including trustworthiness requirements, to be considered and provide an initial design of the solutions developed in WP3.*

On the other hand, this review should also provide the state of the art for other papers in the context of the ENACT project.

## Objectives

#  ● To summarize the existing (Model-based) approaches used in the development, deployment, and adaptation for IoT systems.

# ● To identify any gaps in current research, i.e. in the (continuous) development, deployment, and adaptation for IoT systems.

# ● To provide a strong background in order to appropriately position new research activities that ENACT is aiming at.

# ● No papers on SLR of No papers on SLR of this research domain yet.

# 2. Research questions

A Systematic Review of the continuous development, deployment, and adaptation approaches of IoT systems

Nico: Generally speaking we should also have a look at flow-based programming for the IoT (e.g., NoFlo, Node-red, Devify). Also, we need to provide related work in term of survey of “tools” for the deployment and orchestration of IoT systems. By the way, we should think carefully about the scope of the survey. For instance, maybe we should only focus on continuous deployment and orchestration.

● RQ1: What are the existing approaches for the continuous development, deployment, and orchestration of IoT systems*?*

# ● ￼RQ2: What are the current limitations of these approaches?

# ● RQ3: What are the open issues to be further investigated?

These are the generic questions. We focus on refining RQ1 by answering the following sub-questions. RQ2 and RQ3 are for analysing the overall picture of the state-of-the-art given by RQ1 and its sub-questions.

## RQ1's sub-questions:

● RQ1.1 : What are the trustworthiness requirements of SIS that are addressed by these (model-based) approaches? Trustworthy aspects (e.g., security mechanisms, quality assurance, robustness, resilience, access control, security and privacy)?

# ● RQ1.2 : What are the approaches for the continuous delivery of trustworthy IoT systems? Has any study considered a risk-driven process in the continuous delivery of trustworthy IoT systems?

# ● RQ1.3 : What are the different (model-based) approaches for (continuous) development, deployment, orchestration and adaptation of trustworthy SIS across the vastly heterogeneous IoT, edge and cloud space? How many approaches have in mind a continuous modern agile-like solution?

# ● RQ1.4 : What are the (run-time) adaptation mechanisms for *smart* IoT systems to adapt the systems to context changes? and any possibility to adapt the context (by means of actuation) based on application needs?

# ● RQ1.5 : What are the current (model-based) approaches for run-time context management and actuation conflict handling? => lightly consider

# ●  RQ1.6 : How the current approaches have been evaluated? If yes, what results have been obtained? What other evaluation methods (other than case studies) have been applied to evaluate these approaches?

## Open questions:

* Should we only consider the MBE or MDE approaches? Not necessary?
	+ Nicolas: To me, this depends on how many related works we found. By default, I would not focus only on the MBE/MDE approaches but this could be a differentiating factor so a characteristic in our evaluation framework. Similarly, I would not introduce SIS framework here but again some of the differentiating factor could be: (i) support IoT, edge, cloud and (ii) support actuators.
* Must the primary studies tackle all the phases of continuous development, deployment, and adaptation for cloud-based (smart) IoT systems? => At least modern devops in mind
* Is cloud-based a must? No?
	+ Nicolas: I believe it can be a differentiating factor
* Is agile a must? => not necessary, but just to check if any primary study has?
	+ Nicolas: I believe it can be a differentiating factor
* What "smart" in the SIS means? Smart here means the ability of context-based risk-driven adaptation at runtime.

# 3. Search strategy

## Query String

### Three groups of search terms:

● **Population terms**: keywords that represent the research domains, i.e. Internet of Things; Interoperability; IoT; IoT Platform; Middleware; Web of things; Fog computing; Services;. CPS???

# ● Intervention terms: keywords that represent the techniques supporting the development, deployment, and adaptation for cloud-based (smart) IoT systems, i.e. devops, agile; modeling; meta-modeling; derive; deriving.

# ● Outcome terms: represent different types of DSL for SIS engineering, i.e. metamodel; UML model(s); framework; . smart city; smart home; smart\*

Maybe adding a group of Comparison keywords as well?

### Form the query string:

● The disjunction of the keywords of each group.

# ● The conjunction of the three groups of terms.

## Electronic & Manual Search

### Electronic search within 5 electronic databases:

(Each time, the query string may need to be modified to fit the format requirements of the electronic database before applying it.)

# ● IEEE Xplore

# ● ACM Digital Library

# ● ~~Web of Knowledge (ISI) is a cross repository library => should be covered by others.~~

# ● ScienceDirect (Elsevier)

# ● SpringerLink (MetaPress)

# ● Google Scholar (for Snowballing only)

### Manual search:

We also manually search all published papers in following potentially relevant, peer-reviewed journals:

# ● From related conference proceedings, e.g. ??; and journals, e.g., ???

# Snowballing search

Recursively:

# Backward snowballing: From references of the primary papers, find other primary papers

* Forward snowballing: From the citation of the primary papers, find other primary papers

We use Google Scholar for the forward snowballing process because it would provide the most complete and updated list of citations for a publication.

# 4. Study selection criteria

# Inclusion criteria

# ● Relevant studies for the development, or deployment, or orchestration of IoT systems are included. In other words, a primary study must have an IoT target.

● Primary studies must address the heterogeneous IoT where different IoT platforms can be integrated into seamless IoT systems??

# ● TODO: more points here…

# ● When a single approach is presented in more than one paper describing different parts of the approach, we include all these papers, but still consider them as a single approach.

# ● When encountering more than one paper describing the same or similar approaches, which were published in different venues, we only include the most recent one that has the most complete description of the approach.

# Exclusion criteria

● Papers irrelevant to IoT are excluded. For example, the papers proposing software engineering approaches without focusing on IoT are excluded.

# ● Papers proposing approaches without dealing with interoperability are excluded. For example, approaches for purely security analysis are excluded?

# ● Non-peer reviewed or no significant technical community support publications are excluded.

# ● Papers with insufficient technical information regarding their approaches are excluded. For example, the papers that do not provide a detailed description on ???, are considered incomplete and are excluded (e.g. []).

# ● Publications not in English are excluded.

# 5. Primary study selection procedures

* For each paper, we read the paper's title and abstract to see whether it is relevant to our research topic.

# If the title and abstract of the paper could not help us to make a decision, we further check the paper's full text.

# To enhance our collection of primary studies, we do the snowballing recursively to scan the references and citations of all the identified primary studies to identify additional papers.

# Furthermore, we also go through publication lists of primary studies' authors to make sure that the most recent publications on the same or similar topics are included.

# The relevant candidate and selected studies will be selected by a single assessor. The rejected studies will be checked by another assessor. We will maintain a list candidate papers that were rejected with reasons for the rejection.

# Each prospective primary study will be evaluated by at least two of the authors of this review.

#  The results will be tabulated as follows:

* Number of papers per year per source
* Number of candidate papers per year per source
* Number of selected papers per year per source
* TODO: other things.

# 6. Taxonomy for data extraction and comparison.

TODO: Classification schemes

Main classification spaces:

* SE
	+ DevOps
	+ Agile
	+ Waterfall
	+ Mapping to the Software Development Lifecycle stages?
* Model-Based Engineering vs. Non-MBE
	+ MBE:
		- Modelling Notation
		- Model Transformations (Automation)
		- Modelling Method
	+ Non-MBE:
		- ??
* IoT space
	+ Cloud-based
	+ Fog computing
	+ Heterogeneity
	+ IoT Dev
	+ IoT Deployment and Orchestration
	+ Edge devices
	+ App Domains: Smart City, Smart Home, Smart healthcare
* Trustworthiness space
	+ Security
	+ Performance
	+ Privacy
	+ Robustness,
	+ Resilience
	+ Quality of Service
* General Research classification
	+ Contribution type
	+ Research Type

# 7. Quality assessment checklists and procedures (not necessary explicit)

# Each SLR will be evaluated using the York University, Centre for Reviews and Dissemination (CDR) Database of Abstracts of Reviews of Effects (DARE) criteria (http://www.york.ac.uk/inst/crd/crddatabase.htm#DARE). The criteria are based on four questions:

# 1. Are the review’s inclusion and exclusion criteria described and appropriate?

# 2. Is the literature search likely to have covered all relevant studies?

# 3. Did the reviewers assess the quality/validity of the included studies?

# 4. Were the basic data/studies adequately described?

# The questions are scored as follows:

# · Question 1: Y (yes), the inclusion criteria are explicitly defined in the paper, P (Partly), the inclusion criteria are implicit; N (no), the inclusion criteria are not defined and cannot be readily inferred.

# · Question 2: Y, the authors have either searched 4 or more digital libraries and included additional search strategies or identified and referenced all journals addressing the topic of interest; P, the authors have searched 3 or 4 digital libraries with no extra search strategies, or searched a defined but restricted set of journals and conference proceedings; N, the authors have search up to 2 digital libraries or an extremely restricted set of journals.

# · Question 3: Y, the authors have explicitly defined quality criteria and extracted them from each primary study; P, the research question involves quality issues that are addressed by the study; N no explicit quality assessment of individual papers has been attempted.

* Question 4: Y Information is presented about each paper; P only summary information is presented about individual papers; N the results of the individual studies are not specified.

# The scoring procedure is Y=1, P=0.5 and N or Unknown=0.

# The data will be extracted by one researcher and checked by another.

# 8. Data extraction strategy

# The data extracted from each paper will be:

# TODO: ALL THE EVALUATION CRITERIA ACCORDING TO THE TAXONOMY in Section 7

# The source (i.e. the conference or journal).

# The year when the paper was published. Note if the paper was published in several difference sources both dates will be recorded and the first date will be used in any analysis. This is necessary to track the activity over time.

# Classification of paper

# Type (MBE or not MBE, etc.).

# Scope (Research trends or specific research question).

# Main software engineering topic area.

# The author(s) and affiliation (organization and country).

# Research question/issue.

# The number of related work referred in the paper?

# Summary of paper.

# Quality score for the study.

# The data will be extracted by one researcher and checked by at least one another.

# 8. Data analysis/synthesis

The data will be tabulated (ordered alphabetically by the first author name) to show the basic information about each study. The number of studies in each major category will be counted.

# TODO: just a few intial ideas here! The tables will be reviewed to answer the research questions and identify any interesting trends or limitations in current IoT-related research as follows:

* Question 1: How much IoT activity has there been? This will be addressed by simple counts of the number of IoT related papers per year.
* Question 2: What trustworthy concerns are being addressed? This will be addressed by counting the number of papers addressing each trustworthy concern. We will identify whether any specific areas that addressed by a relatively large number of approaches.
* Question 3: Who is leading IoT research? We will investigate whether any specific organization of researches have undertaken a relatively large number of primary studies.

· Question 4: What are the limitations of current IoT research? We will review the range of IoT topics, the scope of IoT researches and the quality of IoT researches to determine whether there are any observable limitations.

# 9. Timetable

ASAP

# 10. Dissemination

The results of the study should be of interest to the IoT engineering community as well as researchers interested in IoT. We will submit a scientific paper based on the result of this SLR to a workshop/conference and then to a journal?

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