Evaluating the Effects of Architectural Documentation: A Case Study of a Large Scale Open Source Project

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Outline

About the Paper

Context

Motivation

Proposed Work

Study Design

Results

Conclusions

Threats to Validity

About the Paper

- Who:
  - Kazman, Rick (Senior Member IEEE)
  - Goldenson, Dennis (Senior Member IEEE)
  - Monarch, Ira (Software Engineering Institute)
  - Nichols, William (Senior Member IEEE)
  - Valetto, Giuseppe (Member IEEE)
- When: 2015
- Where:
  - IEEE Transactions on Software Engineering (Volume:42 , Issue: 3)

Contribution in Open Source System (OSS)

- Sustaining large Open Source System (OSS) requires continuos recruitment new participants.
- The number of contributors can be used as metric of project sucess.

Objective of Architectural Documentation

- Architectural documentation is believed to serve three major purposes [1]:
  1. providing a means of introducing new project members to the system
  2. serving as a vehicle for communication among stakeholders
  3. being the basis for system analysis and construction

Architectural Documentation in OSS

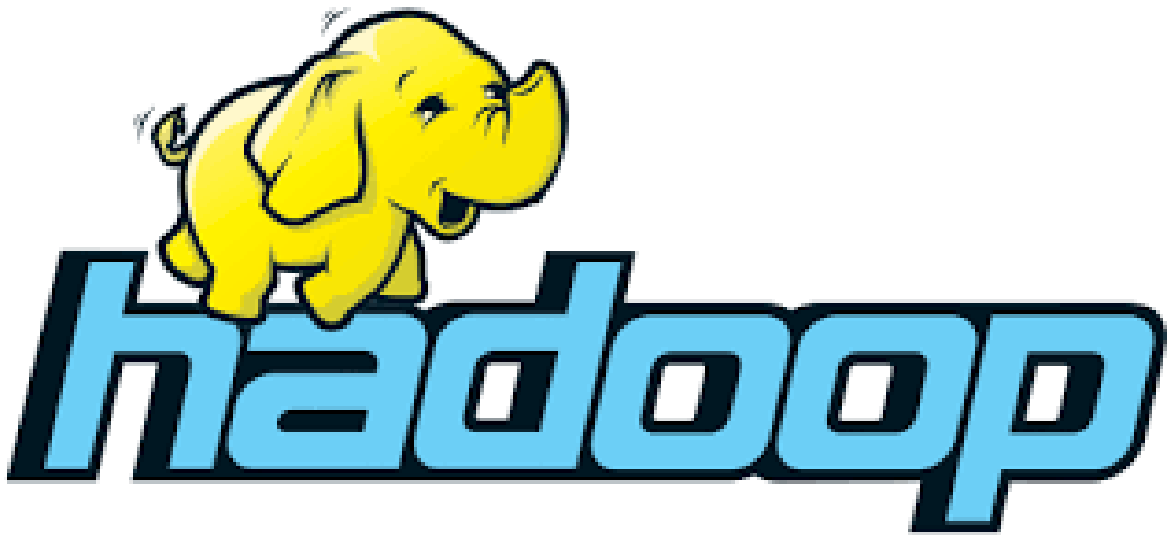
- A lack of architectural documentation might inhibit new participants since large amounts of project knowledge are unavailable to newcomers.
- In 5.4 percent of open source projects have any software architecture documentation [2]

Proposed Work

- This is a multitrait, multimethod analysis of the effects of introducing architectural documentation into a substantial open source project
- The objective is to investigate if and how architecture documentation adds value to a software project.

Open Source System Selection

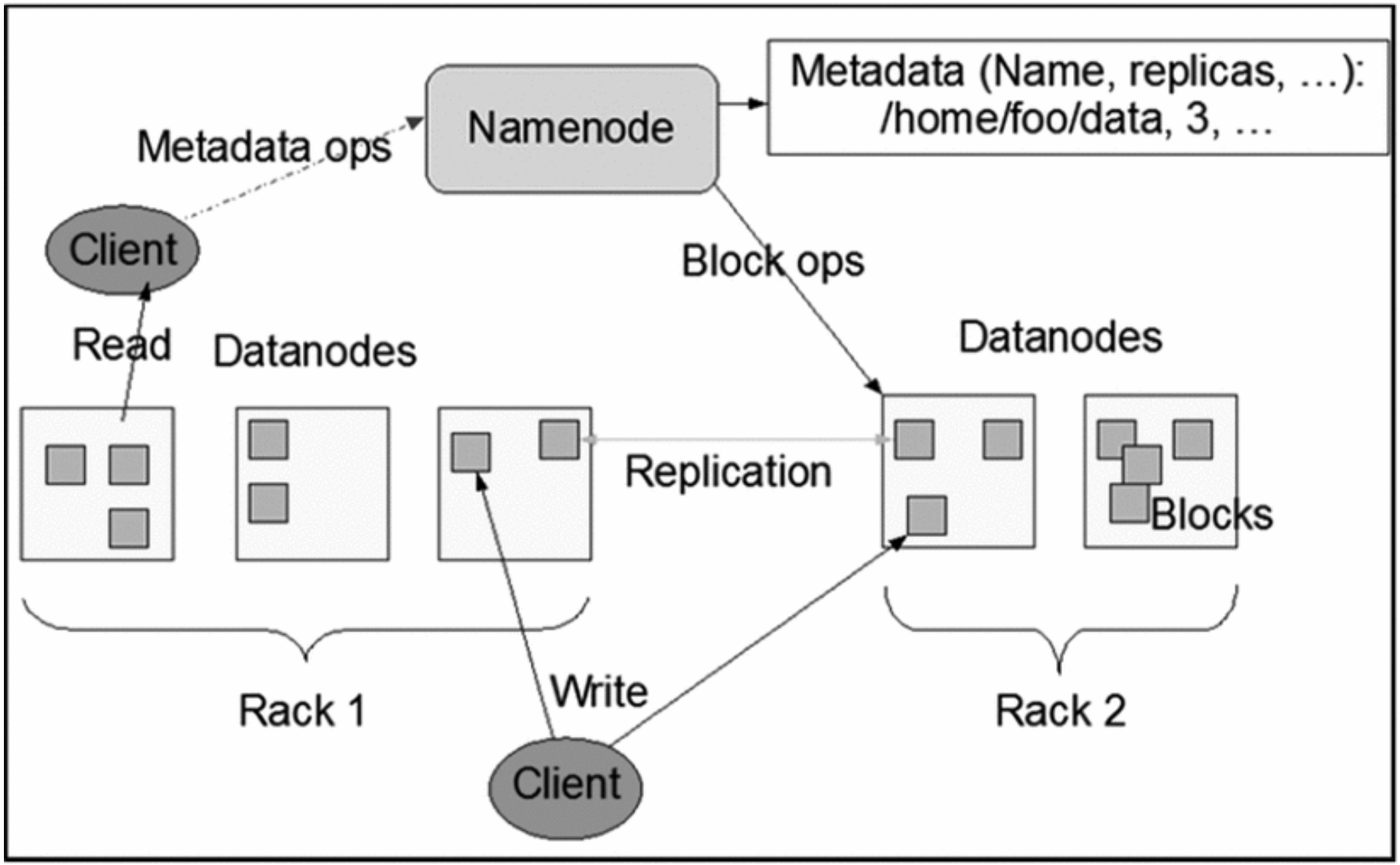
- The study used Hadoop Distributed File System (HDFS)[3].
- The Apache Hadoop project is widely used by large companies such as Yahoo!, eBay, Facebook, and others.



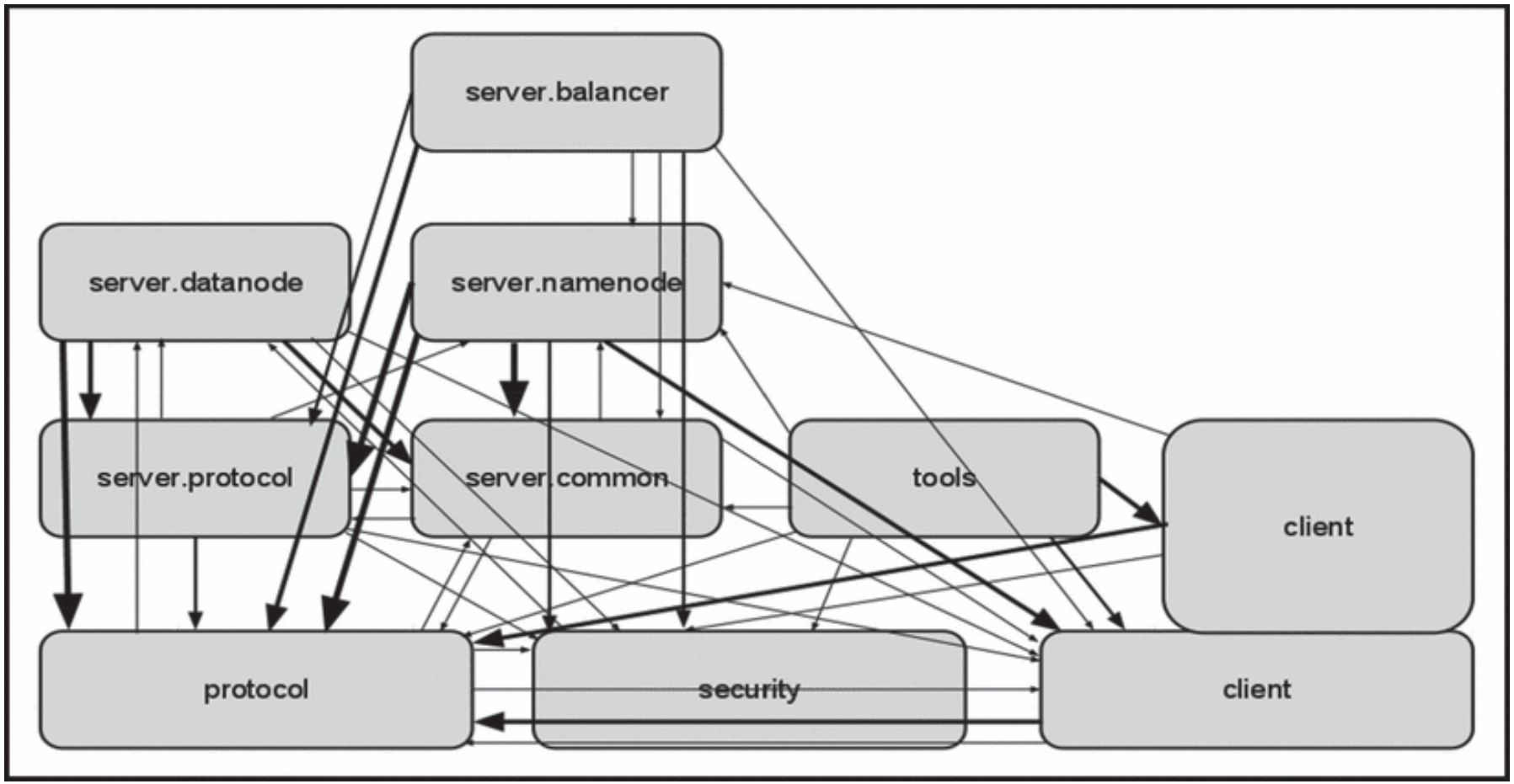
Documenting the HDFS Architecture

- The architecture documentation captured the main abstractions employed in HDFS
- It is also to connect those abstractions to the code (files) that developers work on every day.

HDFS Run-Time Concepts



Documented Module Relationships in HDFS



Research Question

RQ 1.1 Was the architecture document read and if so, how much and how did it change?

RQ 1.2 Was the architecture document referred to by the project Contributors and Committers?

Research Question

RQ 2.1 Was the introduction of the architecture document associated with a change in submission activity?

RQ 2.2 Was the introduction of the architecture document associated with a change in the quality of submissions?

Research Question

RQ 3.1 Was the introduction of the architecture document associated with faster promotion from Commenter to Contributor to Committer?

RQ 3.2 Was the introduction of the architecture document associated with changes in project communication patterns?

Research Question

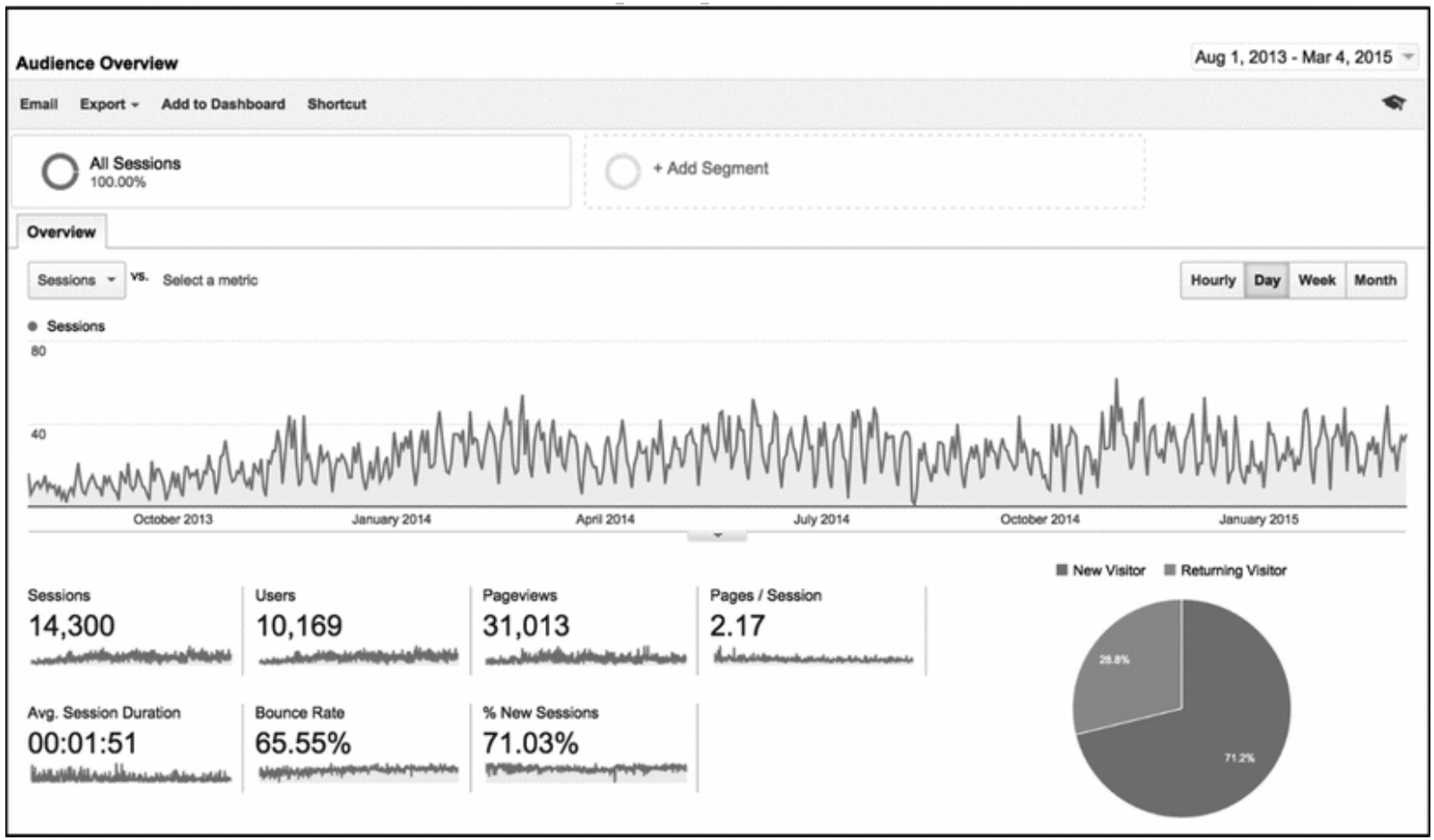
RQ 4.1 Were there any measurable differences in the use of architectural concepts in discussion of issues before and after the architecture document was introduced?

RQ 5.1 How did the Contributors and Committers use the key concepts outlined in the architecture document?

Methodology

Research Question	Methodology
RQ 1.1	Tracking how often the architecture documentation is downloaded and how often it is mentioned in discussion groups
RQ 2.1 & 2.2	Tracking whether any changes have occurred in the interactions and activities of the HDFS developer (Contributors and Committers)
RQ 3.1 & 3.2	Tracking project community health measures, such as the growth of the committer group, and the time lag between someone's appearance as a Contributor and their acceptance as a Committer
RQ 4.1	Tracking whether the introduction of the architecture documentation changed how the project community discussed the system
RQ 2.1 & 2.2	Tracking product performance indicators, such as project capacity—how often Contributors made submissions to the system—and submission quality—how often submissions were rejected by the Committers
RQ 1.2 & 5.1	Surveying the HDFS Contributor and Committer community on their opinions of the value of the architecture documentation that we created

RQ 1.1 Was the architecture document read and if so, how much and how did it change?



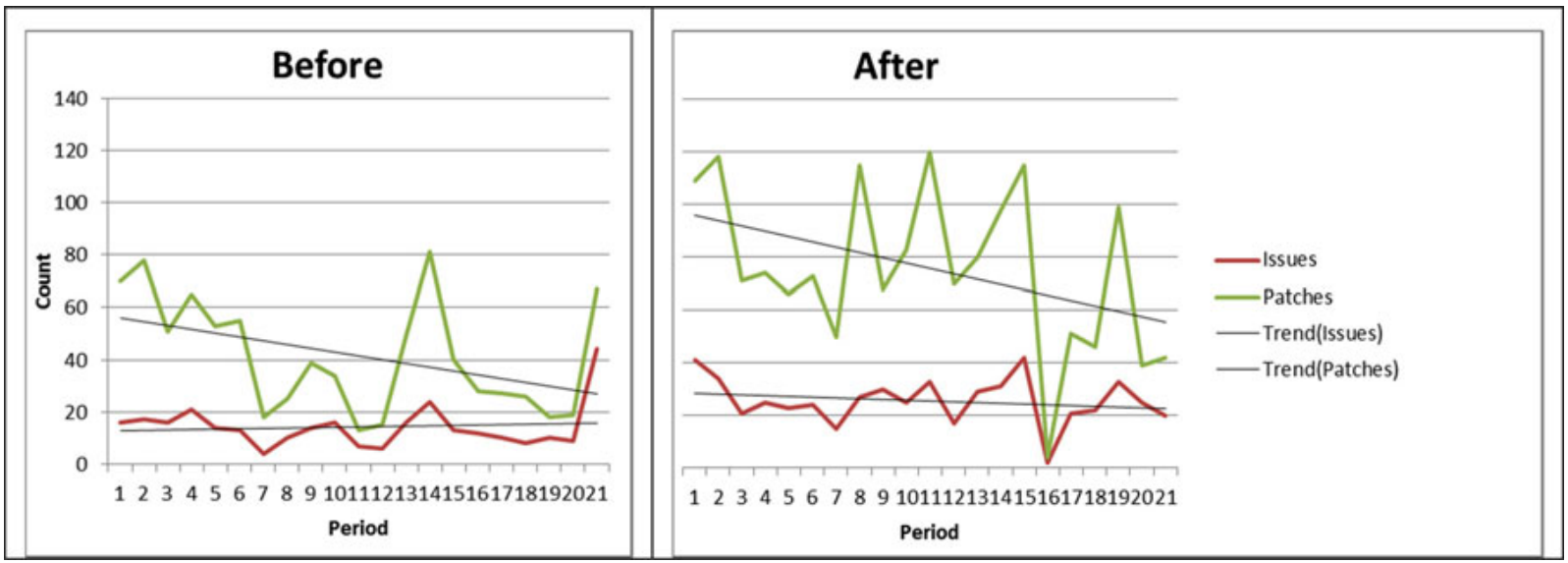
RQ 1.1 Was the architecture document read and if so, how much and how did it change?

- The architecture documentation website was visited over 14,000 times in 19 months
- Almost 30 percent of these visits were from return visitors
- The access rate increased steadily during the study period.

RQ 1.2 Was the architecture document referred to by the project Contributors and Committers?

- Based on survey the Committers and Contributors reported having made relatively little reference to the architectural document itself
- The HDFS Committers appeared to be beginning to advise others about the existence of the documentation available on the Internet.

RQ 2.1 Was the introduction of the architecture document associated with a change in submission activity?



RQ 2.2 Was the introduction of the architecture document associated with a change in the quality of submissions?

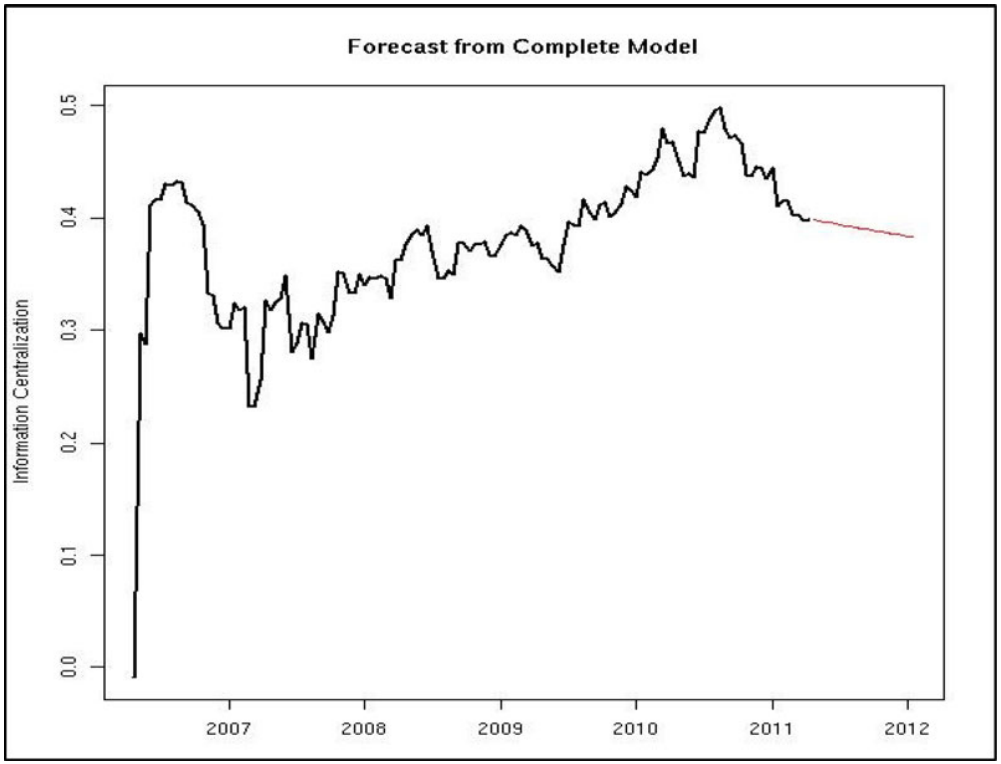
Per period	Mean		Standard Error		p	r
	Before	After	Before	After		
Issues	14.3	25.7	1.83	1.94	0.0002	0.06
Patches Submitted	40.1	74.1	4.76	6.86	0.0002	0.17
Commits	28.3	49.1	3.15	4.87	0.006	-0.18
Rejects	17.2	35.4	2.63	3.85	0.0002	0.38
Commits per issue	2.04	1.91	0.13	0.14	0.58	-0.51
Rejects per issue	1.25	1.34	0.15	0.12	0.58	0.32
Rejects/Commits	0.757	0.997	0.088	0.105	0.051	-0.05
Issues Resolved	19.4	29.9	3.98	2.42	0.067	-.039
Critical and Block-ing Issues Resolved	1.71	3.76	0.737	0.697	0.022	-0.12

RQ 3.1 Was the introduction of the architecture document associated with faster promotion from Commenter to Contributor to Committer?

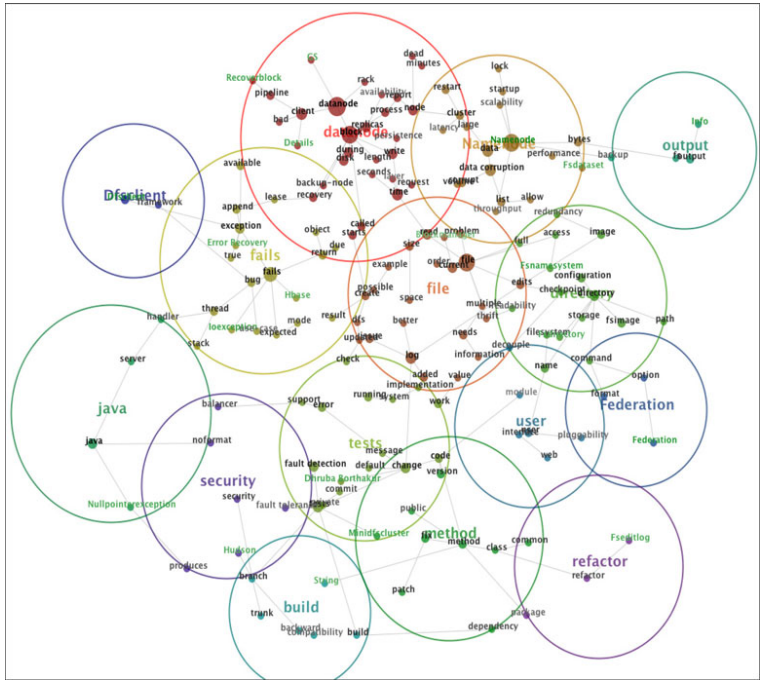
$$\text{Commenter} \rightarrow \text{Contributor} \rightarrow \text{Committer} \quad (1)$$

	N	Min.	1st Quartile	Median	Mean	3rd Quartile	MAX	Std. Dev.
Group1	50	2	13.75	56	82.12	132	269	76.08
Group2	11	2	7.5	27	28.36	37.5	80	26.59

RQ 3.2 Was the introduction of the architecture document associated with changes in project communication patterns?



RQ 4.1 Were there any measurable differences in the use of architectural concepts in discussion of issues before and after the architecture document was introduced?



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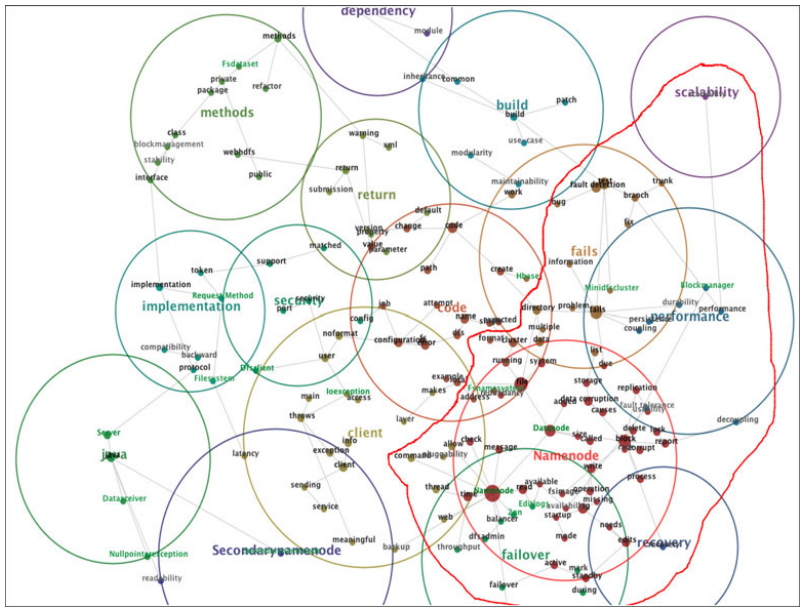

RQ 5.1 How did the Contributors and Committers use the key concepts outlined in the architecture document?

- Contributors and Committers we surveyed clearly recognized the importance of the concepts that were covered in the architectural document and used them in their own work on the HDFS codebase.
- they sometimes tended to focus more heavily on implementation details than architectural considerations *per se*.

Conclusions

- he HDFS Committers appear to maintain intellectual control over their code base. They can do this because the code base is not very large and because they are a relatively small, stable, and co-located group. Therefore, the architecture documentation did not interest or affect the Committers (as measured by their response to our surveys and their lack of referring to it in the JIRA postings and mail archives). The HDFS community of Committers (and the most active Contributors) is actively interested in architectural concepts, as shown by the text

Threats to Validity

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Questions?

References I

[1] P. Clements, D. Garlan, L. Bass, J. Stafford, R. Nord, J. Ivers, and R. Little, *Documenting software architectures: views and beyond*. Pearson Education, 2002.

[2] W. Ding, P. Liang, A. Tang, H. v. Vliet, and M. Shahin, "How do open source communities document software architecture: An exploratory survey," in *Engineering of Complex Computer Systems (ICECCS), 2014 19th International Conference on*, Aug 2014, pp. 136–145.

References II

[3] K. Shvachko, H. Kuang, S. Radia, and R. Chansler, "The hadoop distributed file system," in *Mass Storage Systems and Technologies (MSST), 2010 IEEE 26th Symposium on*. IEEE, 2010, pp. 1–10.