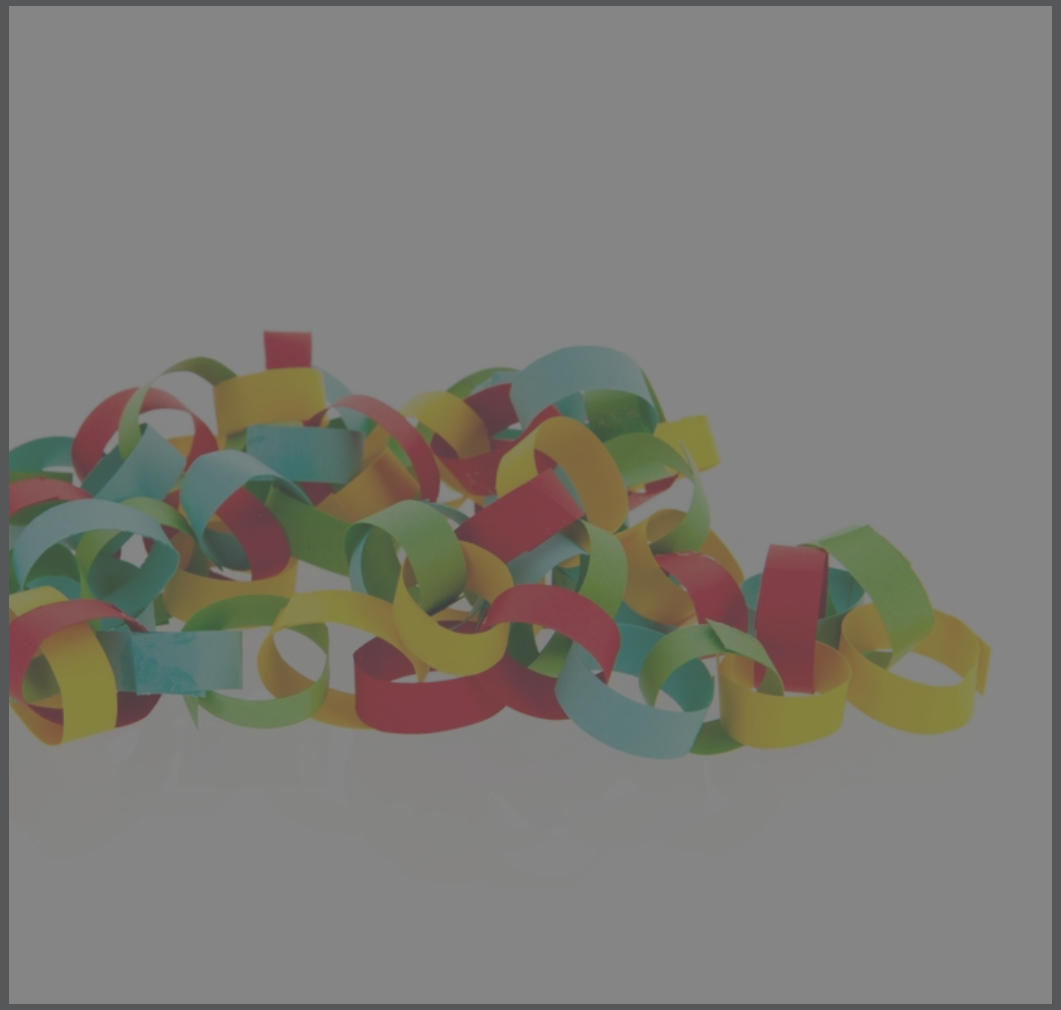
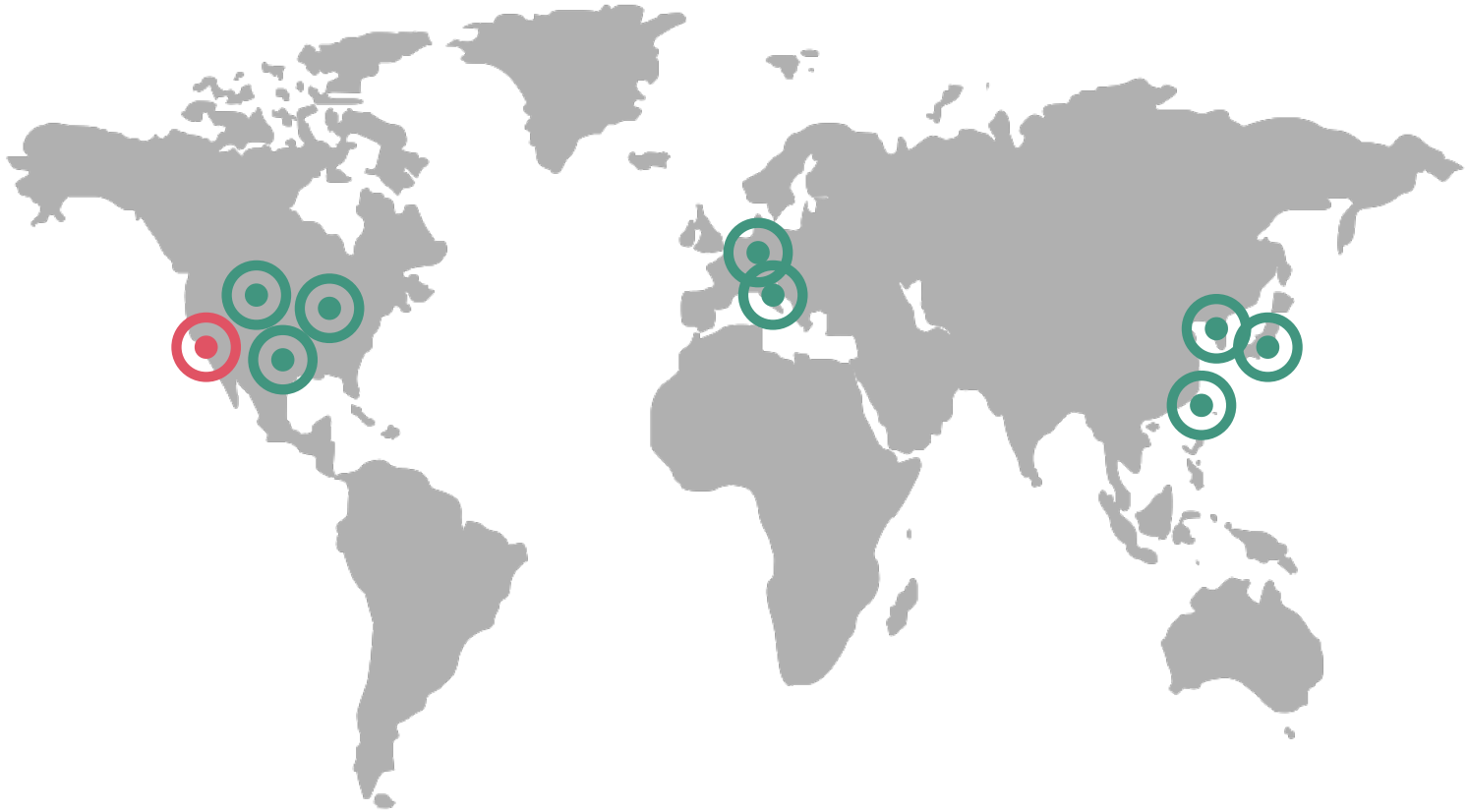


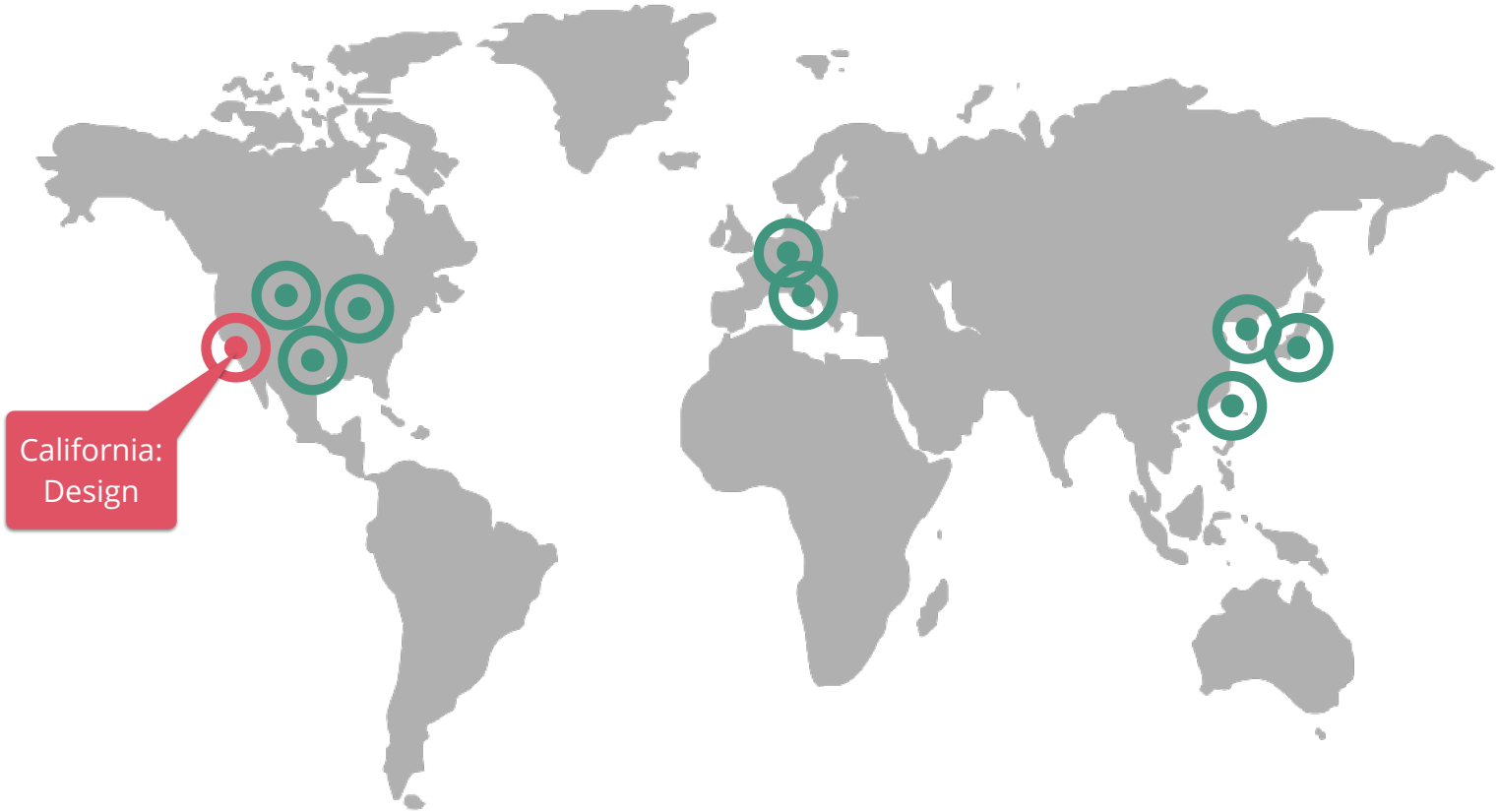
Software Supply Chains

Gail Murphy
Univ. of British Columbia
Tasktop Technologies

@gail_murphy

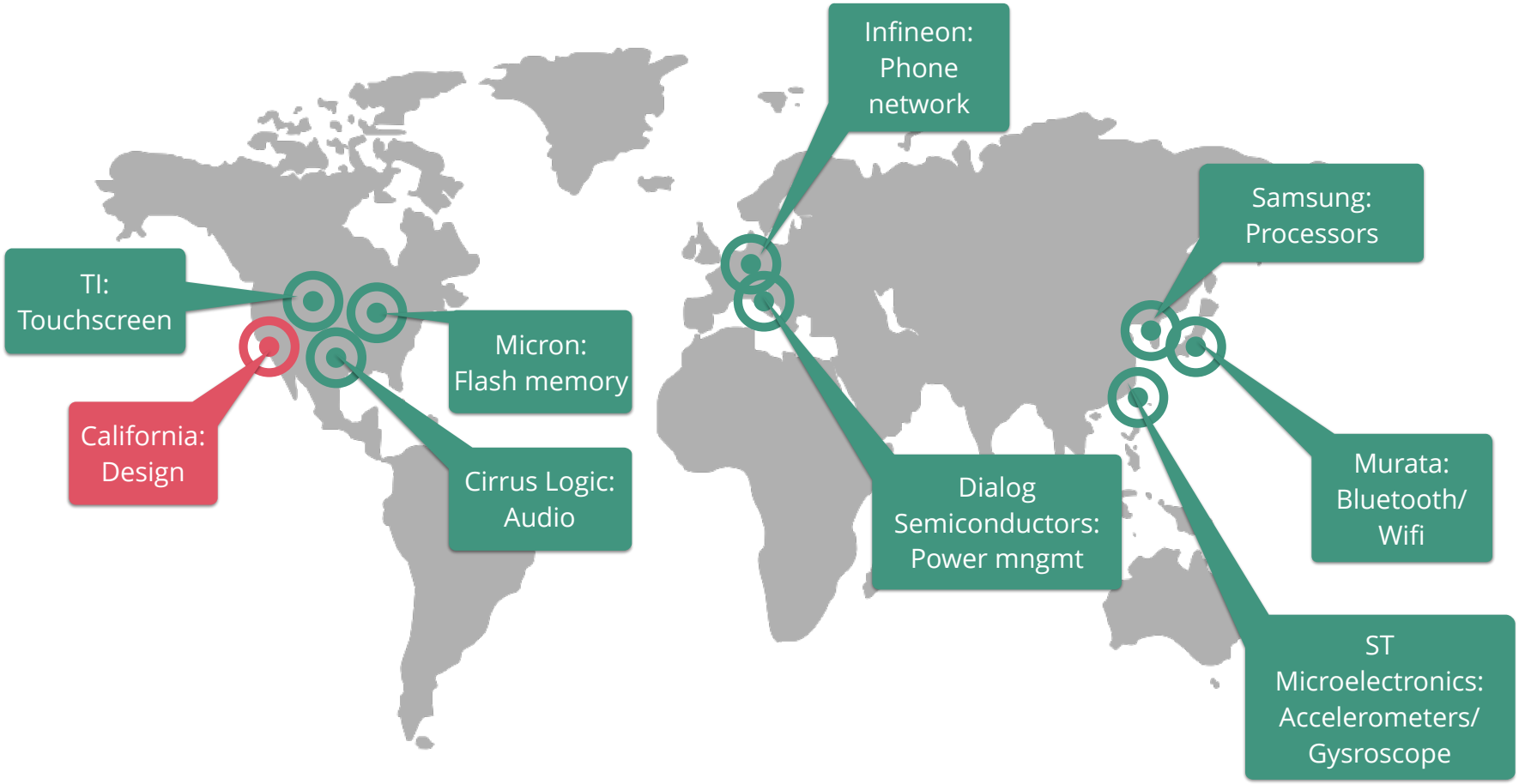


Source: Supply Chain 24/7, 09/14



Source: Supply Chain 24/7, 09/14

iPhone Supply Chain



Source: Supply Chain 24/7, 09/14

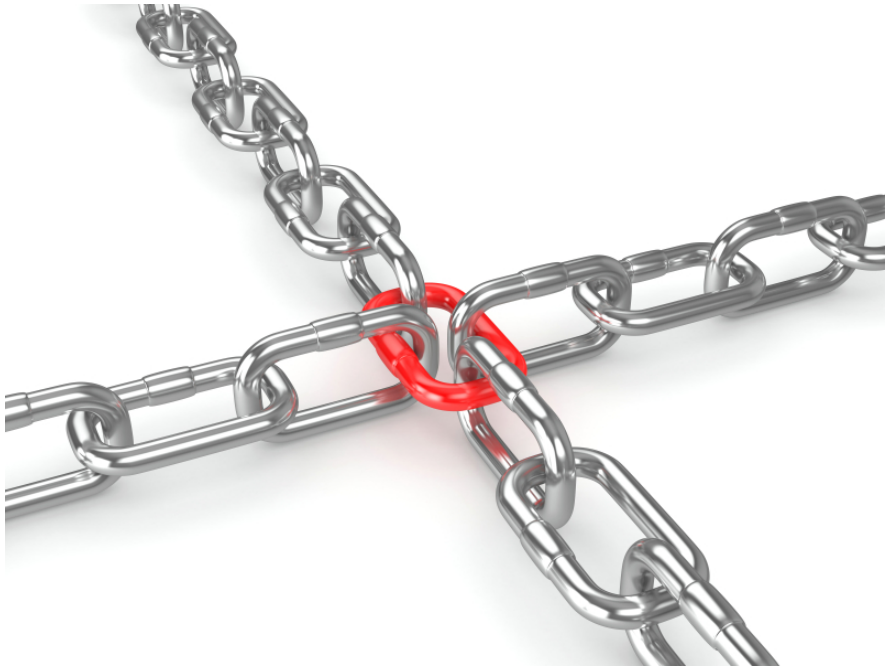
Software Supply Chains

Loose Software Supply Chain

2014: Central Repository of Java open source components

2015 State of the Software: Supply Chain Report (Sonatype)

Tight Software Supply Chain

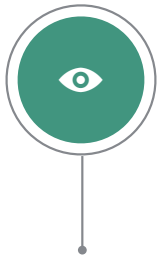


All is good?

Outline

Outline

Naïve View



Outline

Naïve View

Reality: Loose Supply Chain

Outline

Naïve View

Reality: Loose Supply Chain

Reality: Tight Supply Chain

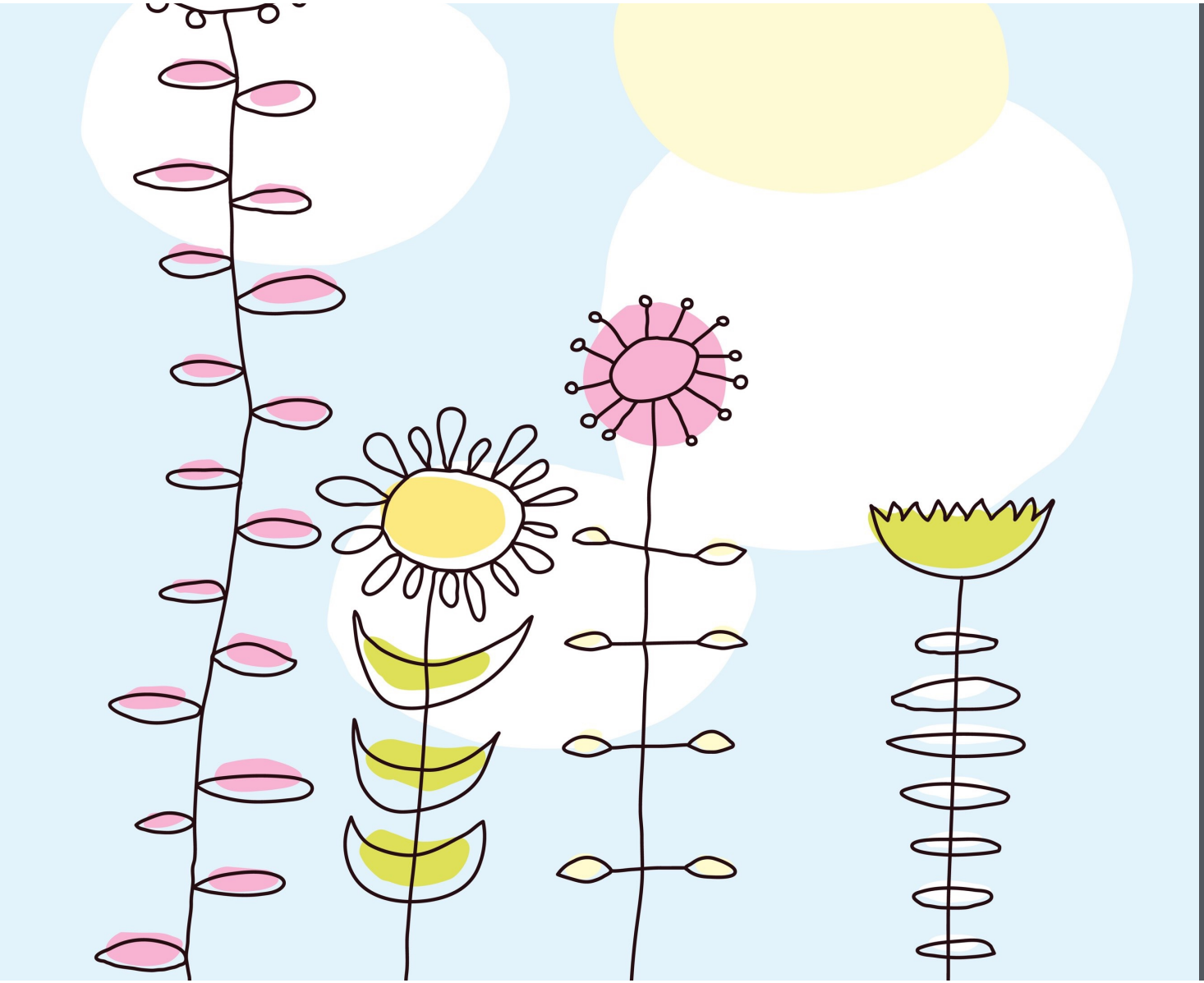
Open Problems

Key points:

(re)use is not free
controlled transparency

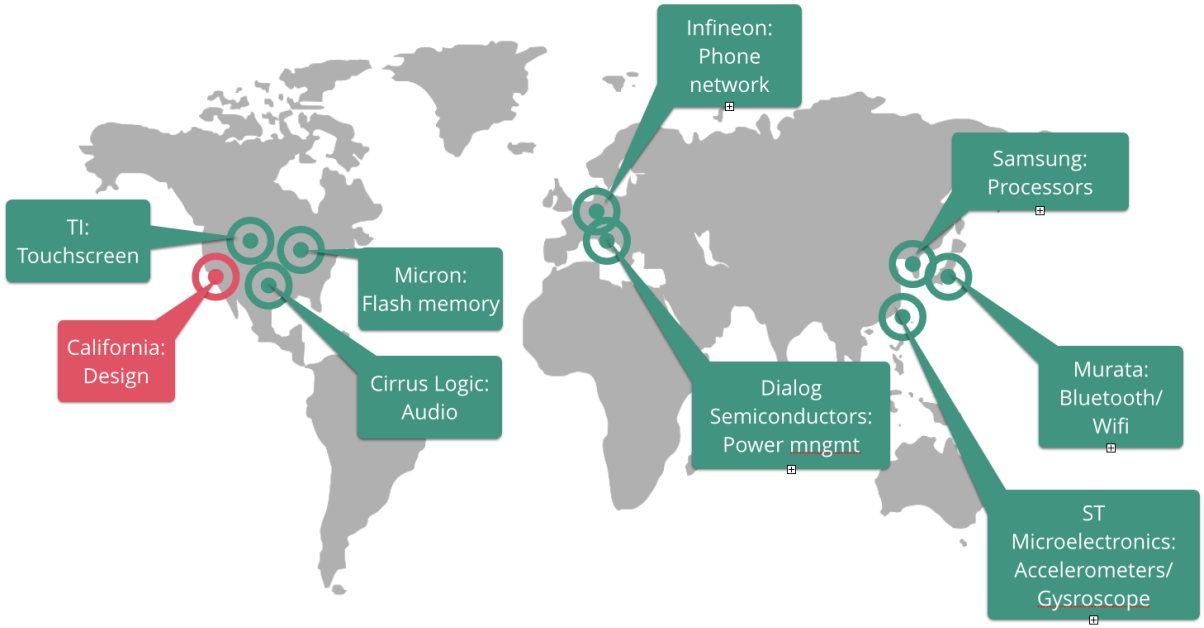
Caveats:

challenges over solutions



Naïve View

Supply Chain: suppliers, parts, manufacturers, finished goods…



specialized excellence

lower costs

higher quality

Software Supply Chain Spectrum

Bouncy Castle
used >> 10K organizations

Loose

Tight

Loose

(vast) majority of developers are part of a software supply chain

suppliers

components

YOU!

software

Naïve View

Apache TomEE™

Loose

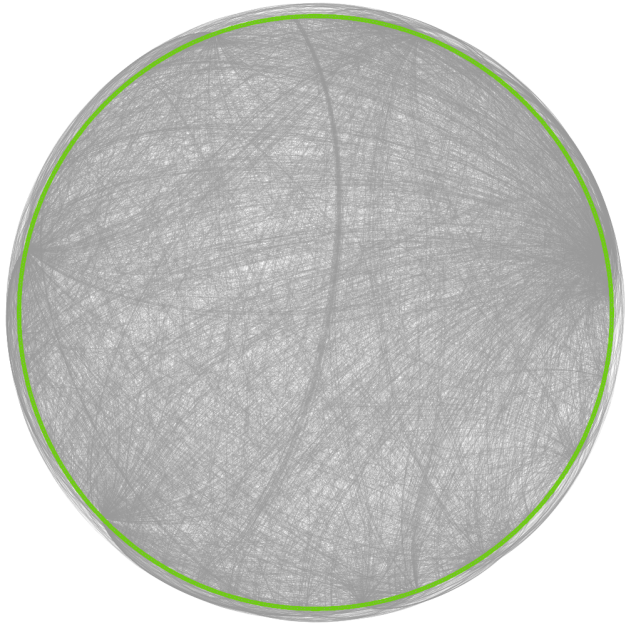
>105K

suppliers

>834K

total components

central repository



GitHub project dependences

Loose

- build products (and other components) faster
- higher-quality components
- low cost to (re)use
- ongoing updates

Naïve View

Tight

multiple tiers of contractually-obligated suppliers

Boeing → General Electric → Hydro-Aire

Naïve View

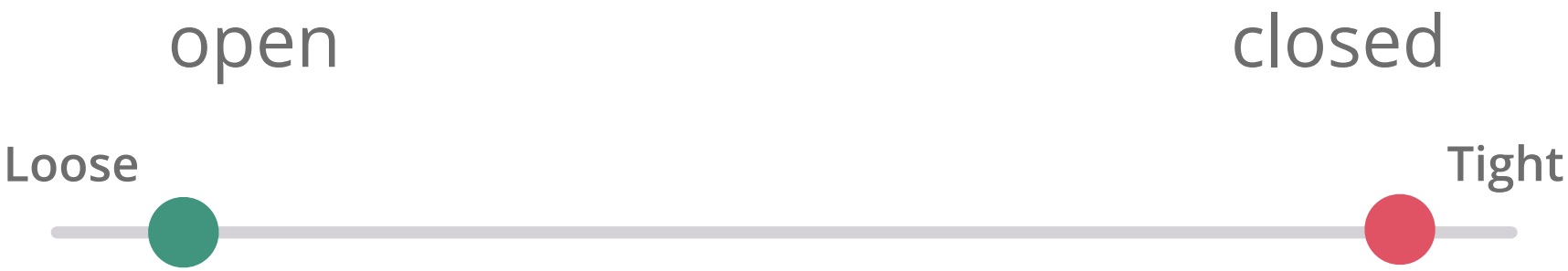
Tight

+ higher-quality components

+ on-time production

+ lower overall product cost

Software Supply Chains



faster, better, cheaper

Photo copyright Gniot/Shutterstock

Reality View:

Loose Supply Chain

Two Parts

Two Parts

Social

Two Parts

Social

Quality

Two Parts

Social

Quality

Social Implications of OSS Library Use

#1 How often does the use of an OSS library lead to a social link between projects?

#2 Do social contributions occur before or after a dependence is introduced on a library?

#3 What kind of social contributions occur?

Palyart and Murphy, 2015, under review

Terminology

user
project/
repository

library
project/
repository

issue
comments
pull request
commit

Palyart and Murphy, 2015, under review

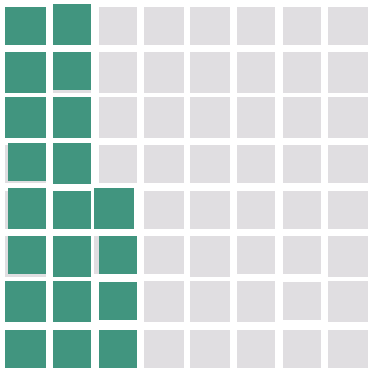
Data

- =1,125 GitHub repos

Palyart and Murphy, 2015, under review

Data

=1,125 GitHub repos



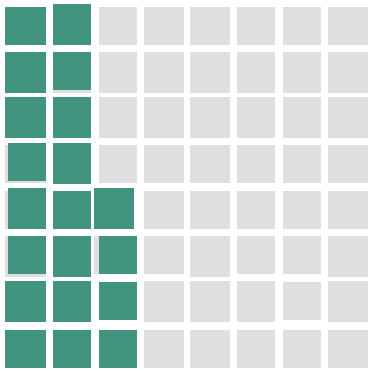
23,059

- not a fork
- public
- forked at least twice
- use Maven

Palyart and Murphy, 2015, under review

Data

=1,125 GitHub repos



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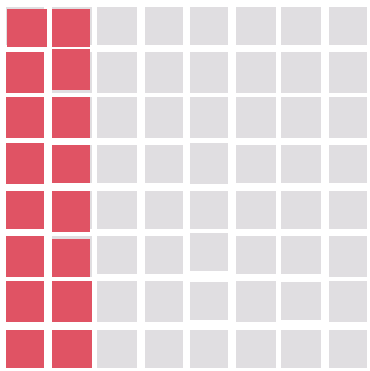
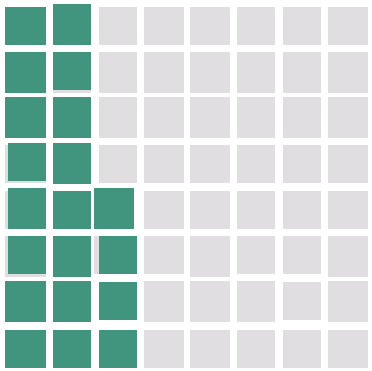


17,900 - depend on GitHub

Palyart and Murphy, 2015, under review

Data

=1,125 GitHub repos



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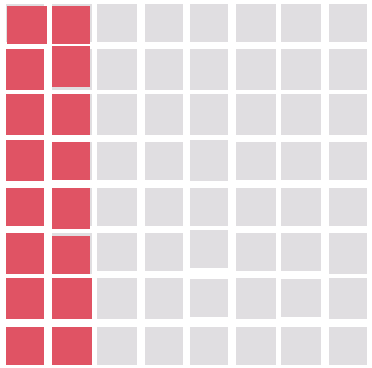

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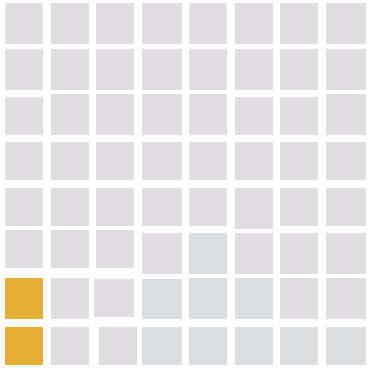
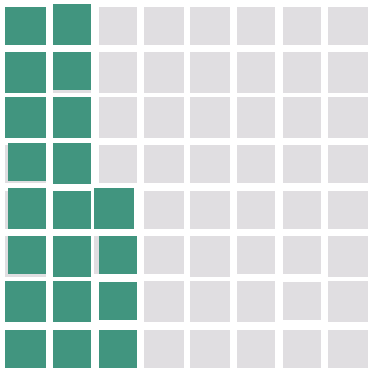


1,409
- > 20 issues
- issues > 5% pull requests
- handle account deletions

Palyart and Murphy, 2015, under review

Data

=1,125 GitHub repos



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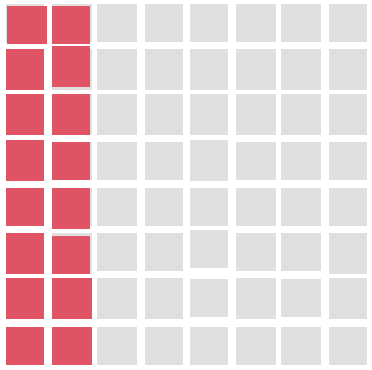

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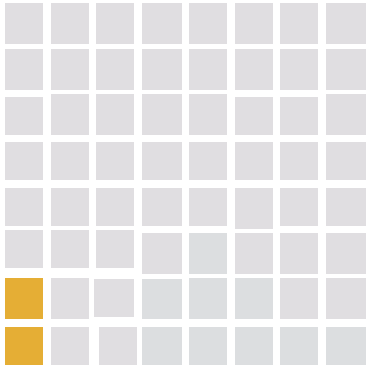

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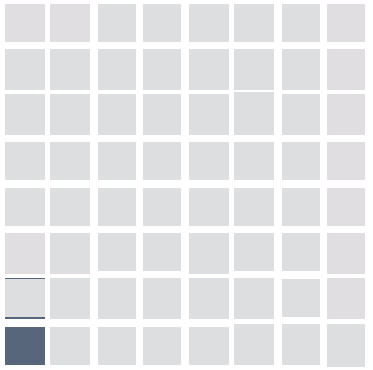


1,227 - high confidence in correct library dependences

Palyart and Murphy, 2015, under review

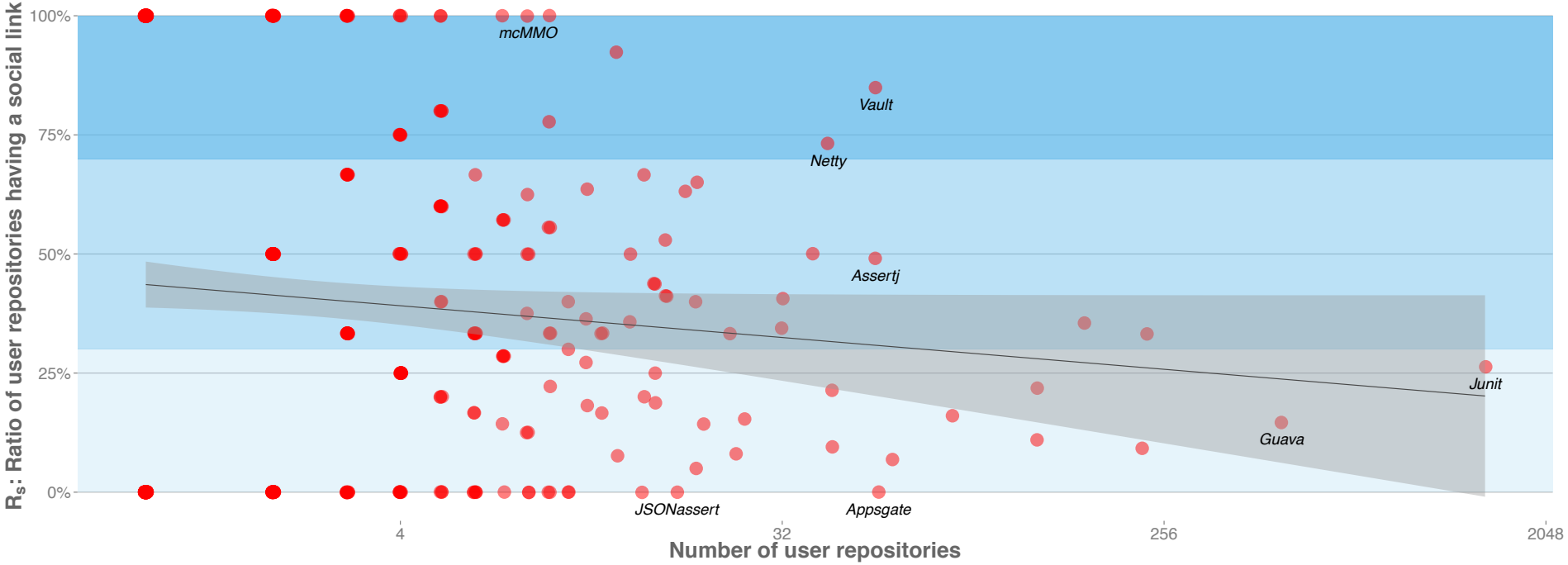
Data

Technical Link

Social Link

Palyart and Murphy, 2015, under review

#1 - How often does library use lead to social links?



Palyart and Murphy, 2015, under review

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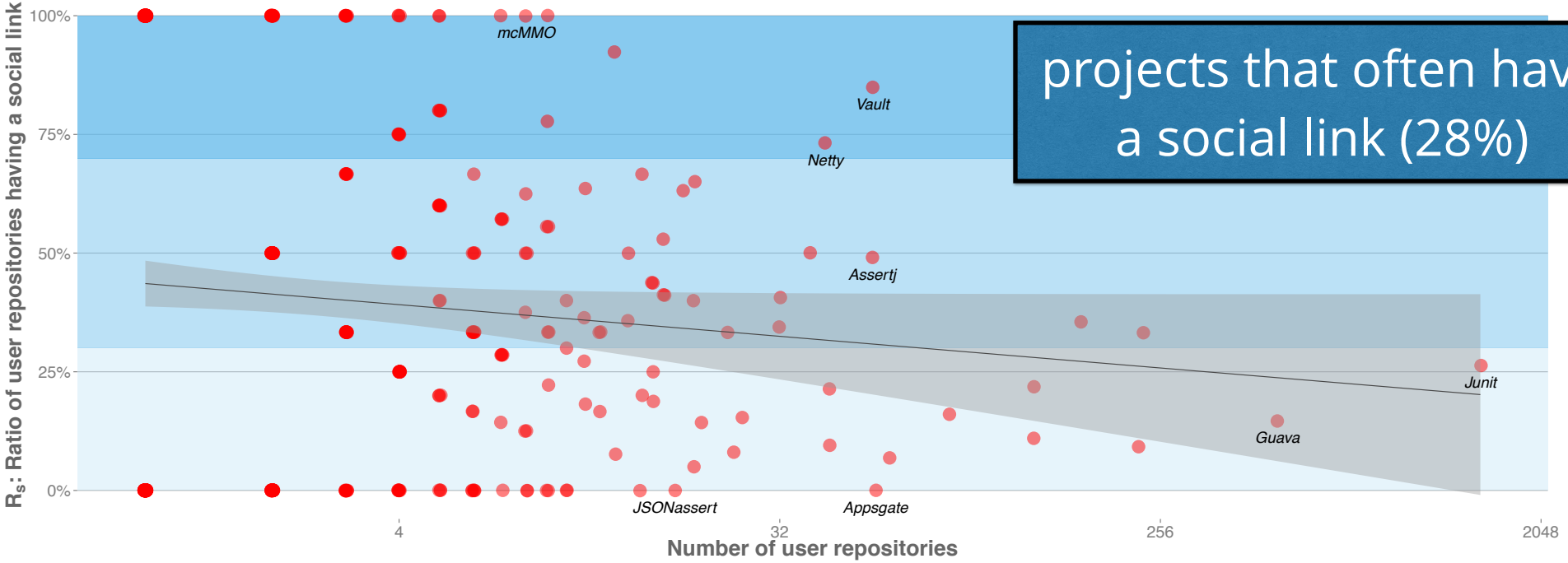

projects that often have a social link (28%)

Palyart and Murphy, 2015, under review

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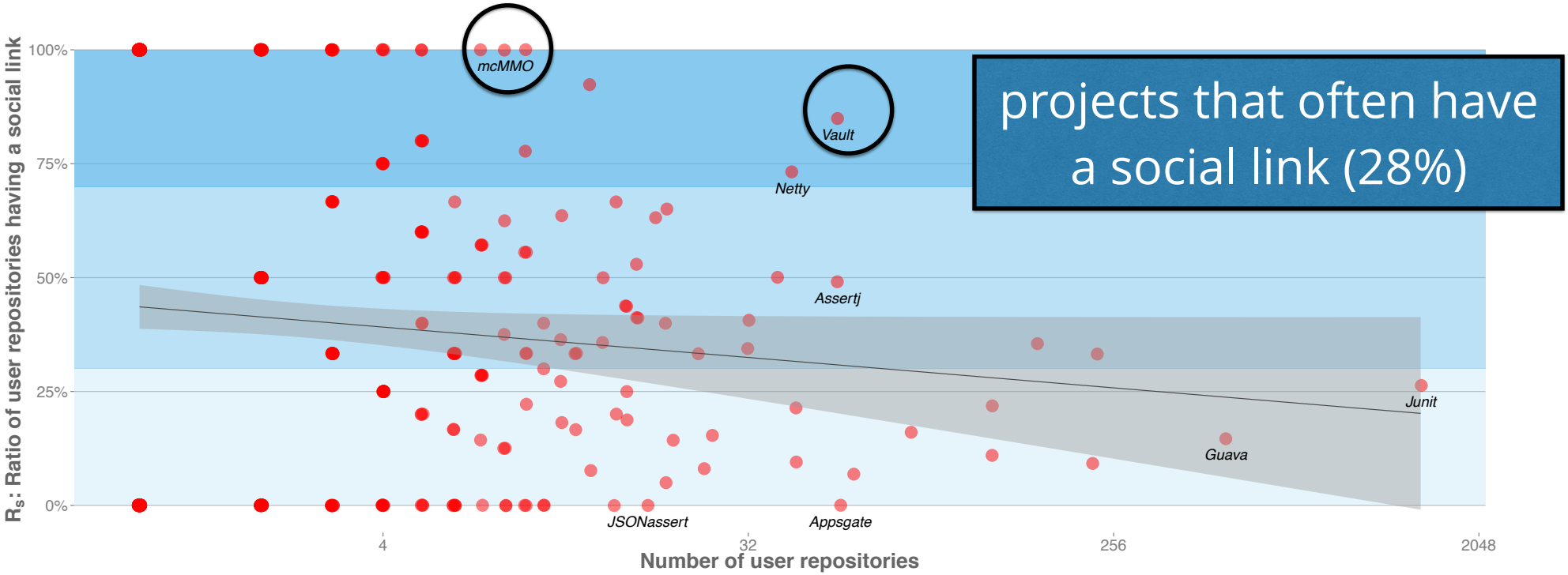

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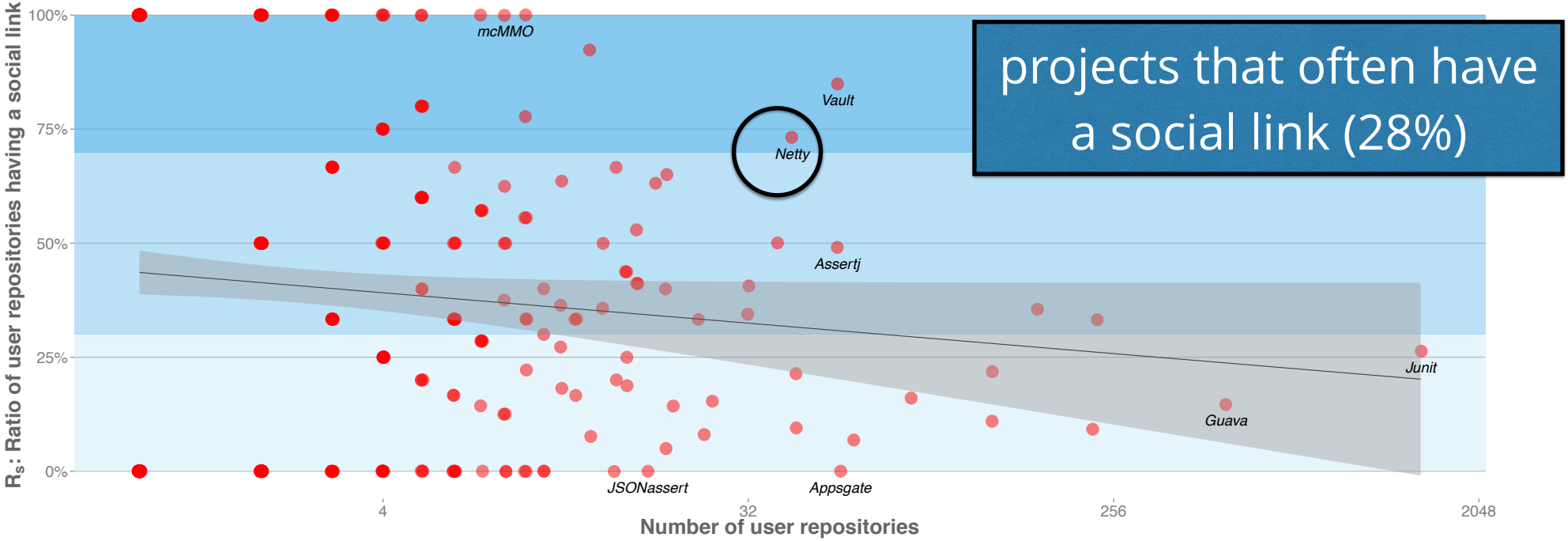

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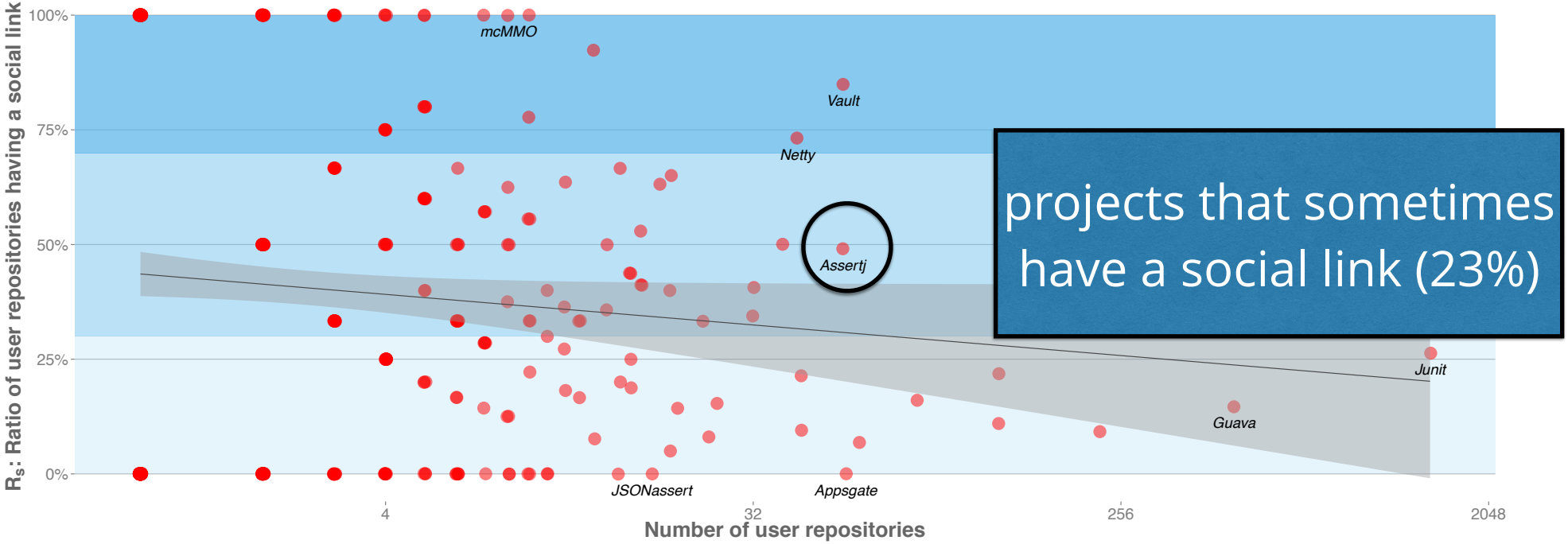

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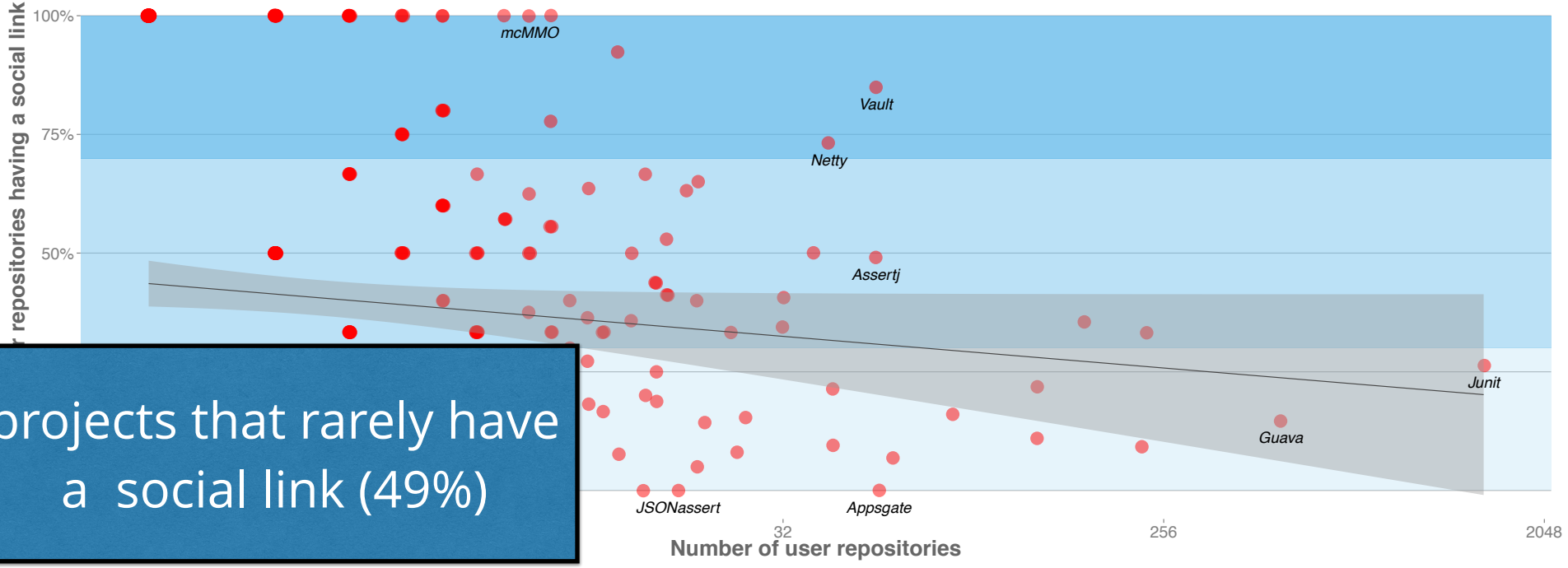

projects that rarely have a social link (49%)

Palyart and Murphy, 2015, under review

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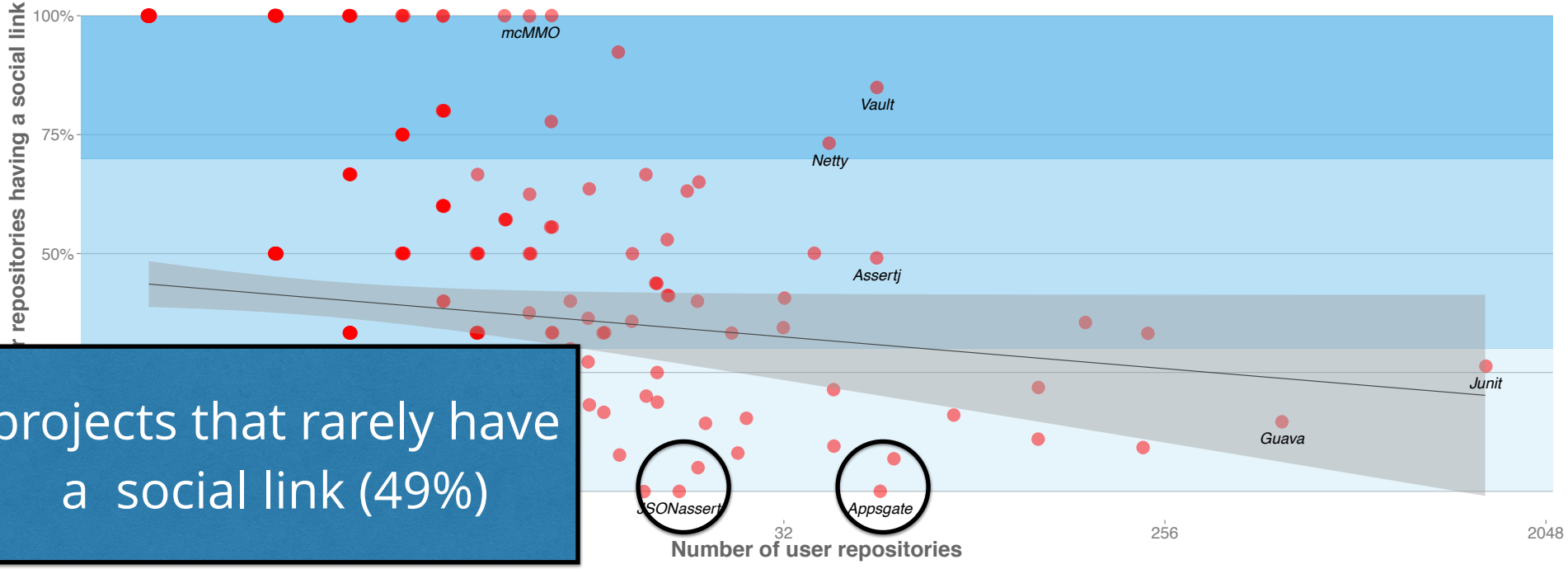

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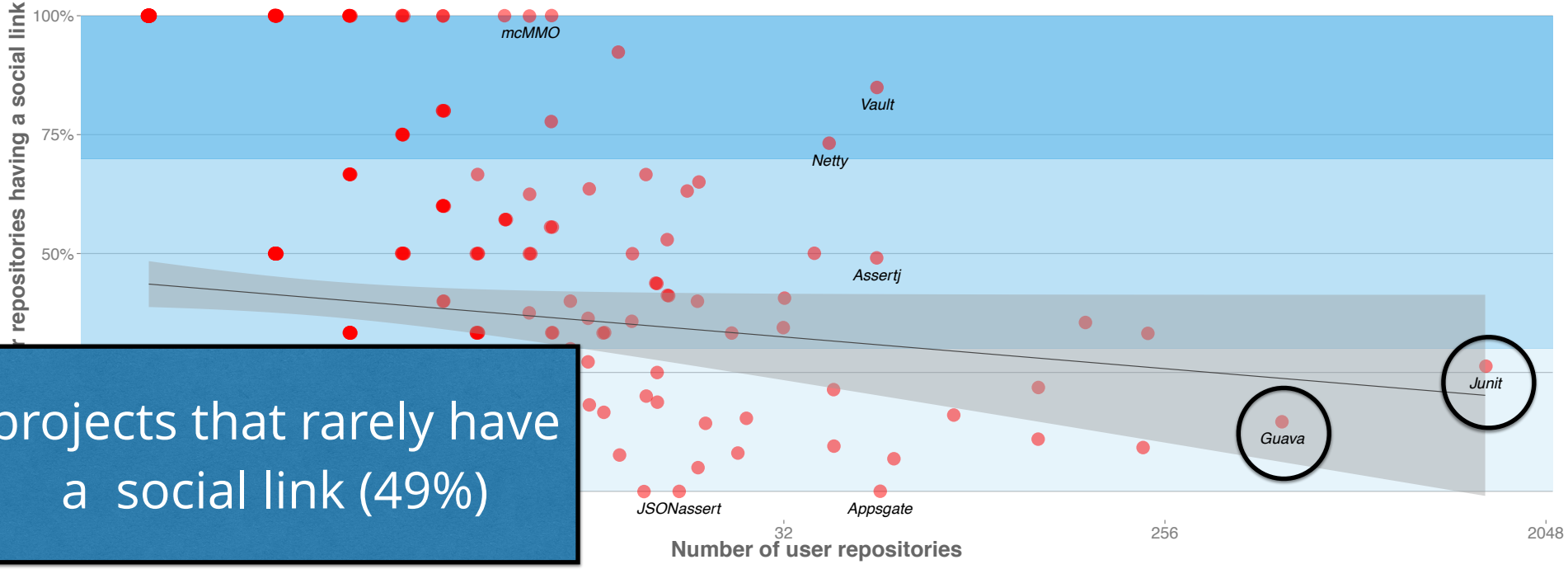

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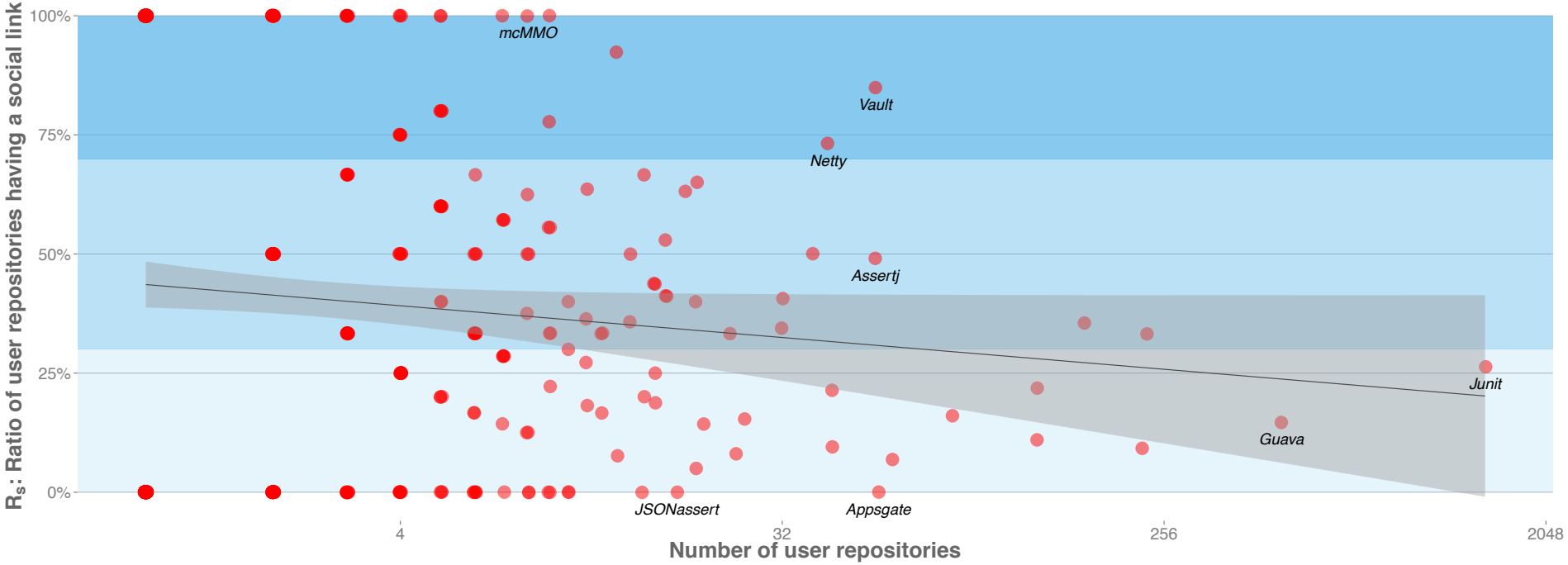

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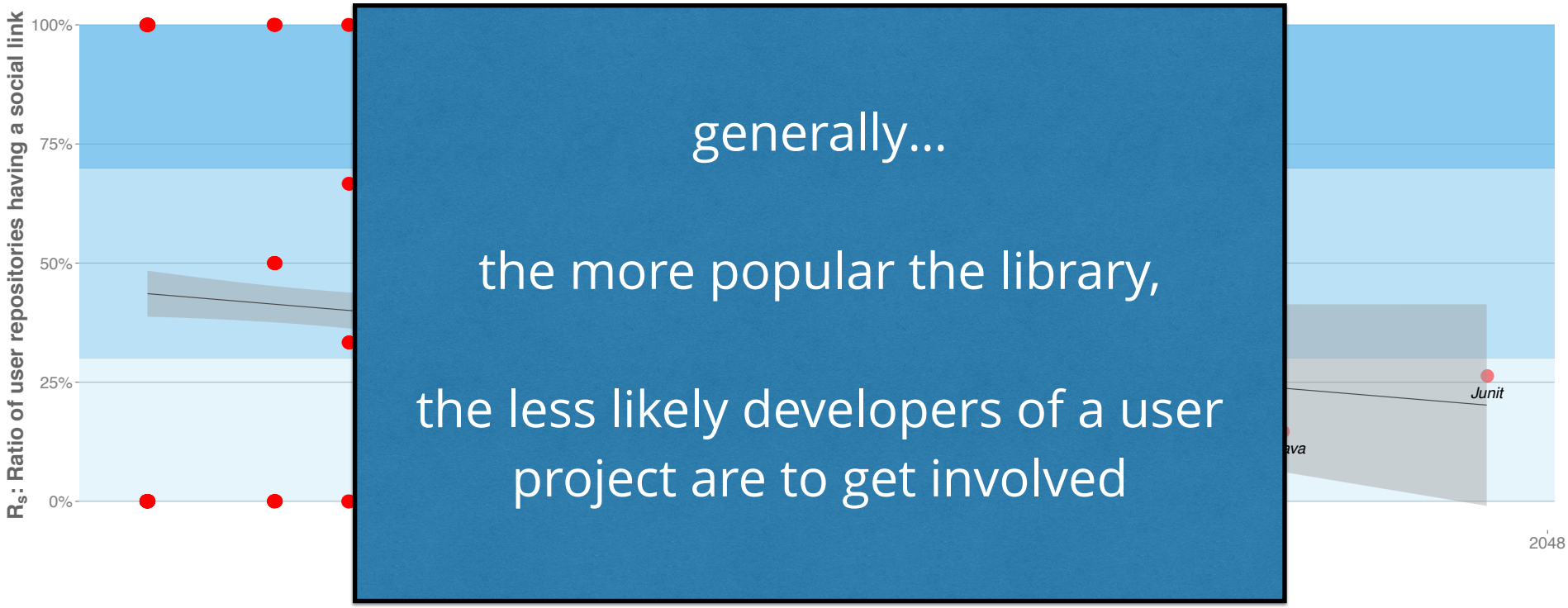


generally...

the more popular the library,

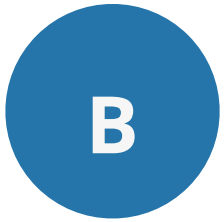
the less likely developers of a user project are to get involved

Palyart and Murphy, 2015, under review

#2 - When do social contributions occur related to library use?

→ Technical Link

→ Social Link



Palyart and Murphy, 2015, under review

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Technical Link

Social Link

Palyart and Murphy, 2015, under review

#2 - When do social contributions occur related to library use?

Technical Link

Social Link

Palyart and Murphy, 2015, under review

#2 - When do social contributions occur related to library use?

Technical Link

Social Link

in only 61% of pairs,
did technical precede social

Palyart and Murphy, 2015, under review

#2 - When do social contributions occur related to library use?

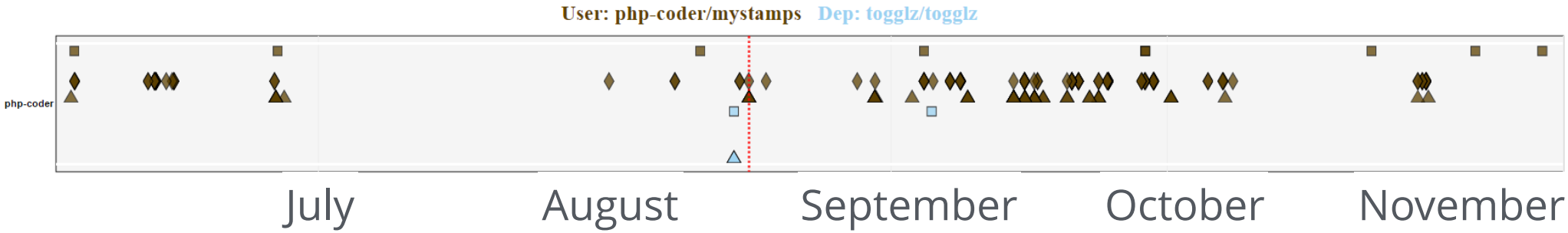
social before technical

http://www.cs.ubc.ca/~mpalyart/stc_timeline/

Palyart and Murphy, 2015, under review

#2 - When do social contributions occur related to library use?

social before technical



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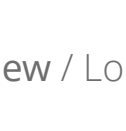
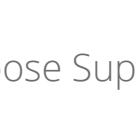
Palyart and Murphy, 2015, under review





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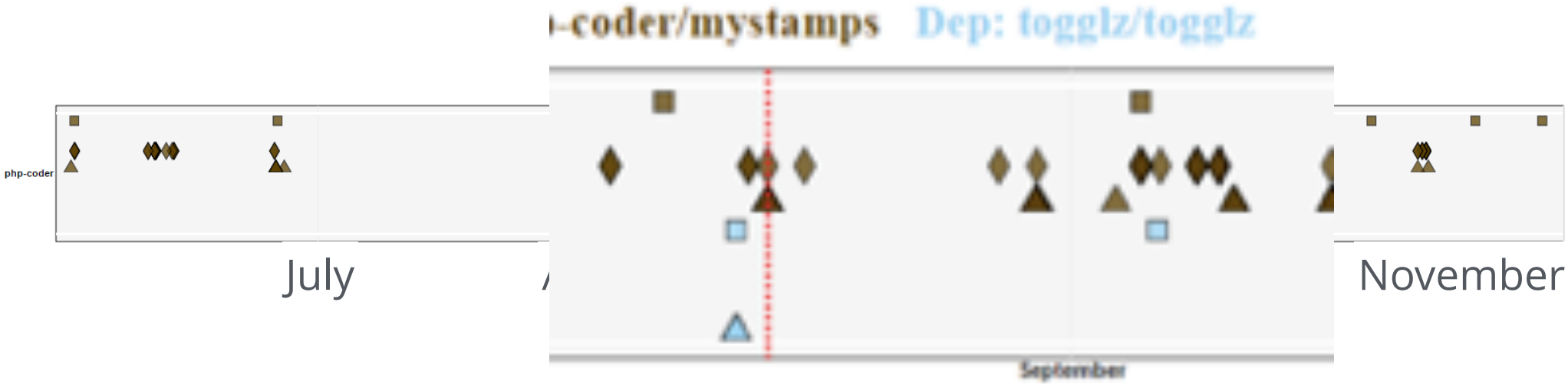

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Palyart and Murphy, 2015, under review

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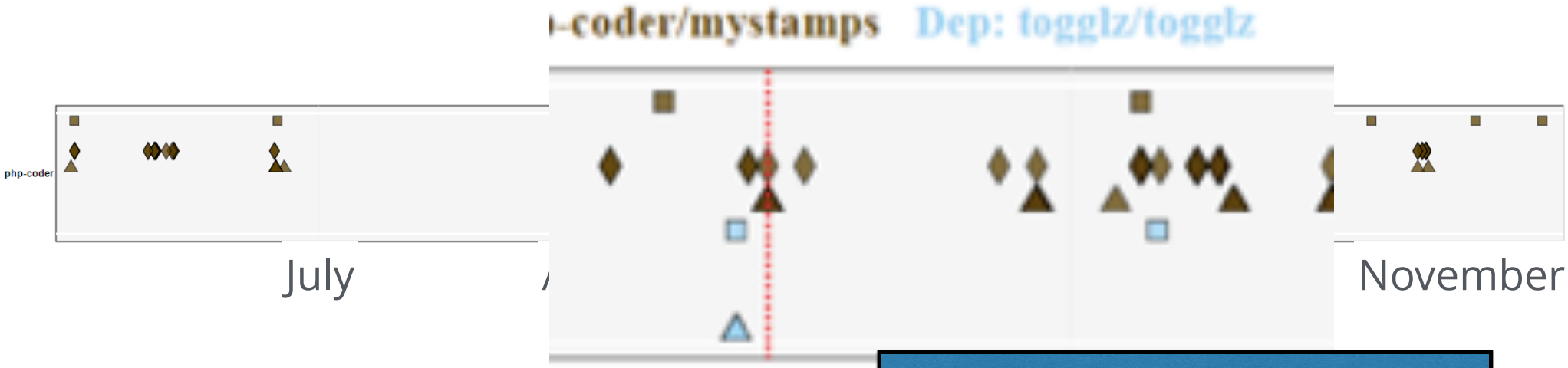

in 39% of pairs,
social preceded technical

http://www.cs.ubc.ca/~mpalyart/stc_timeline/

Palyart and Murphy, 2015, under review

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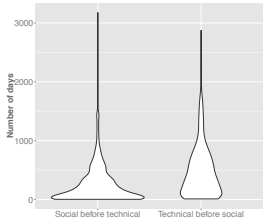

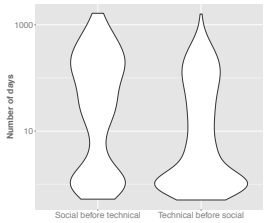

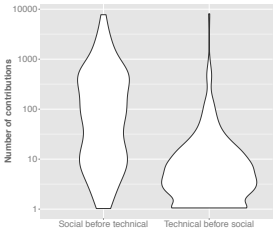

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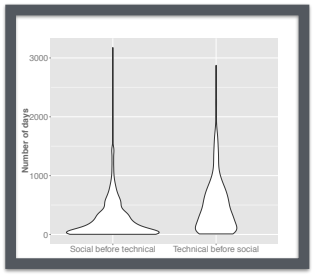
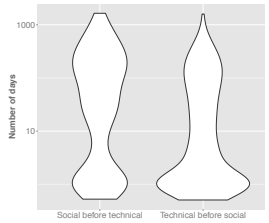
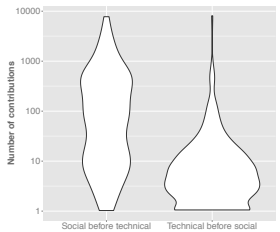
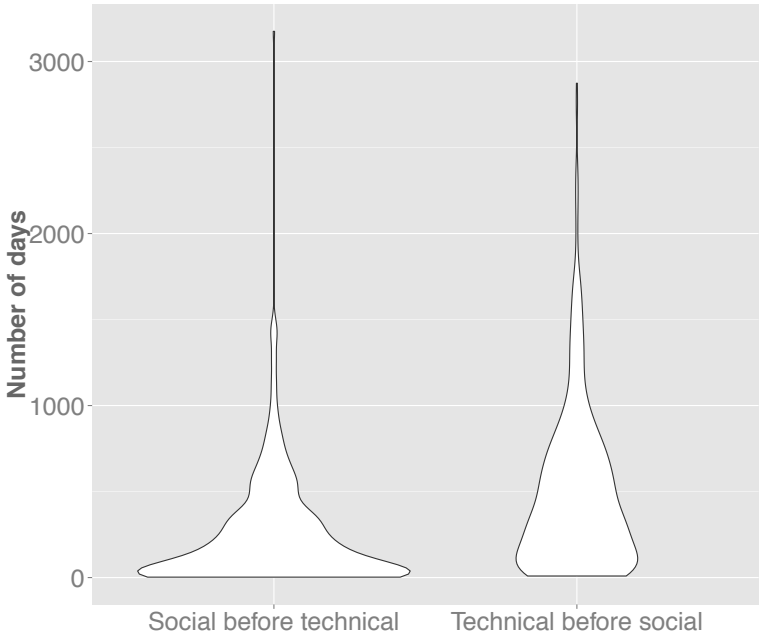






time to involvement



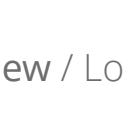
social before technical

most interactions within a few months

t**echnical before social**

more interactions span a longer time

Palyart and Murphy, 2015, under review



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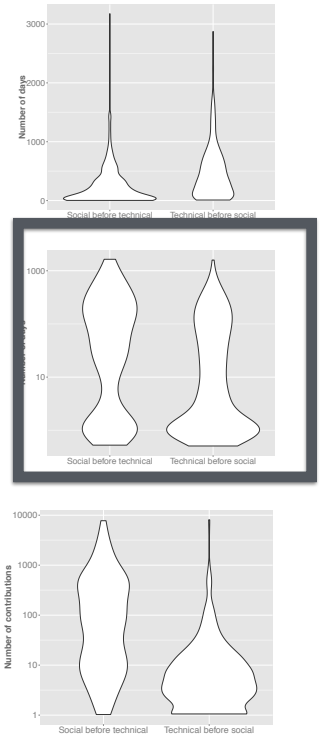
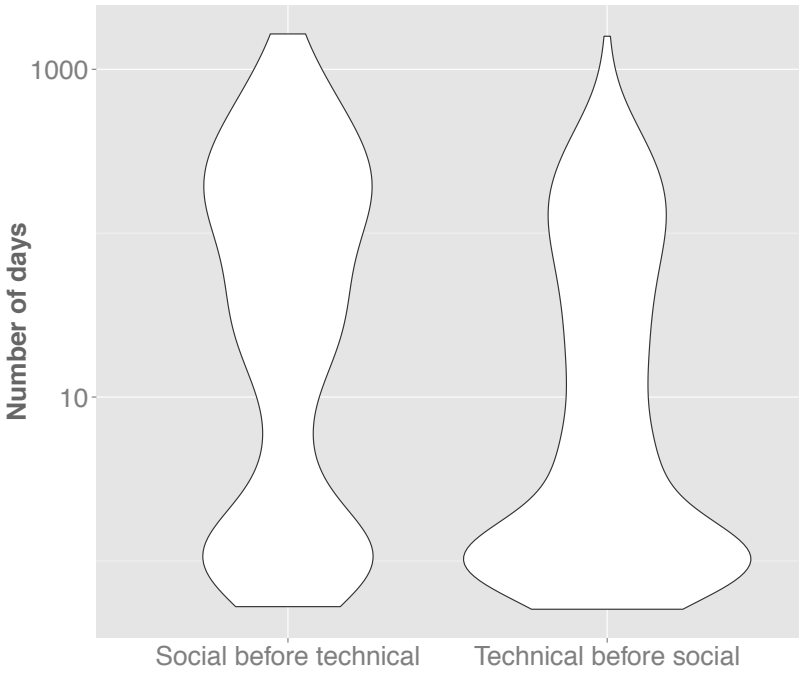


duration of involvement



social before technical

either short involvement or quite long

technical before social

most involvement under 5 days

Palyart and Murphy, 2015, under review

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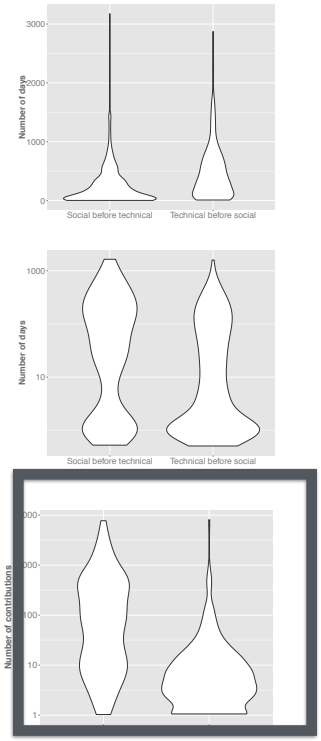
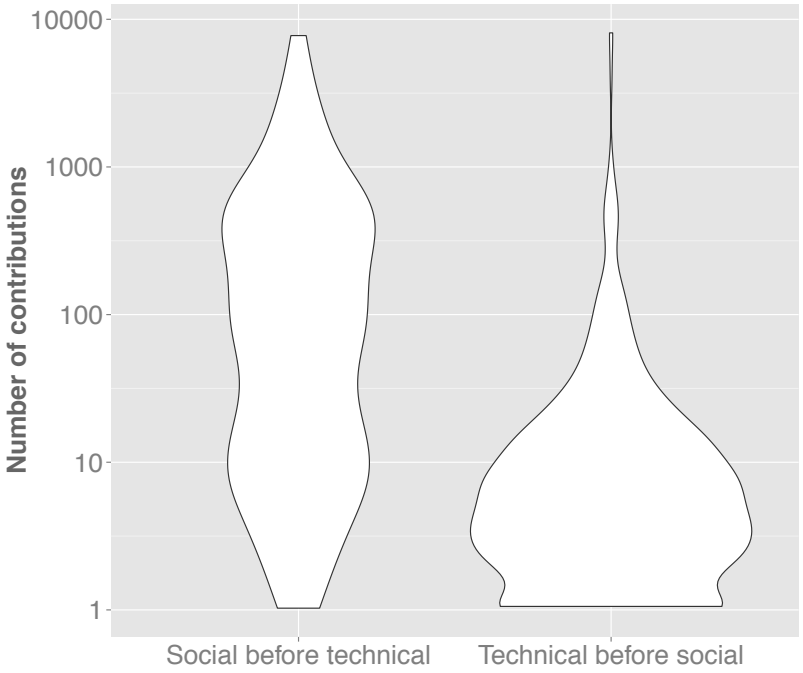


number of contributions



social before technical

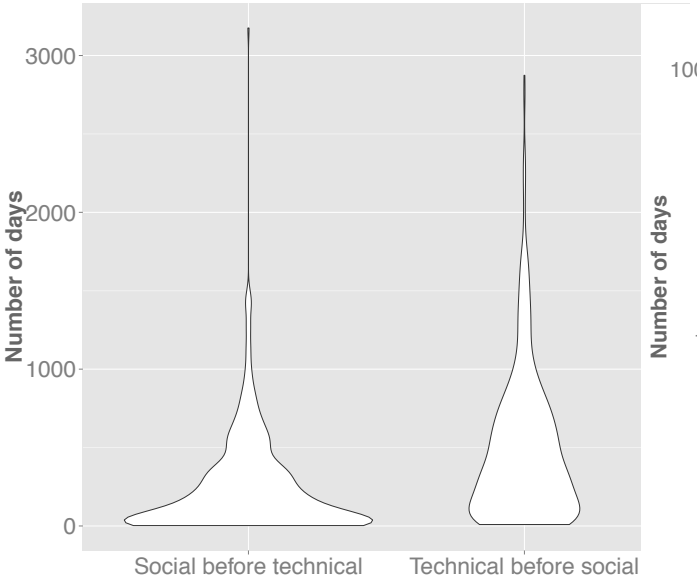
more contributions, stronger communities?

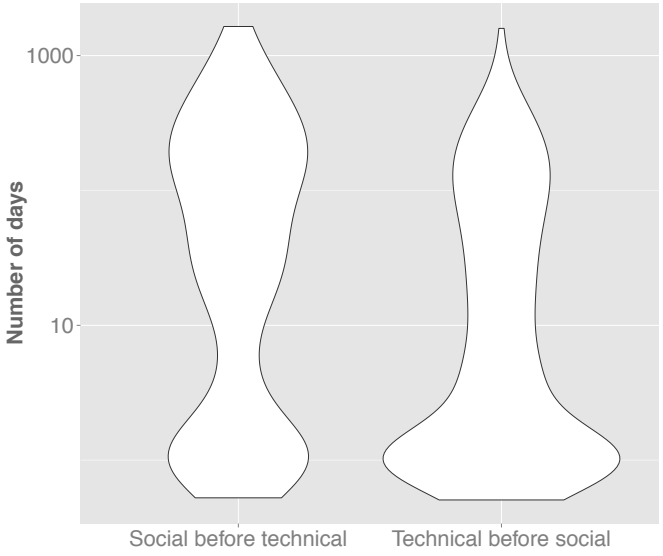
technical before social

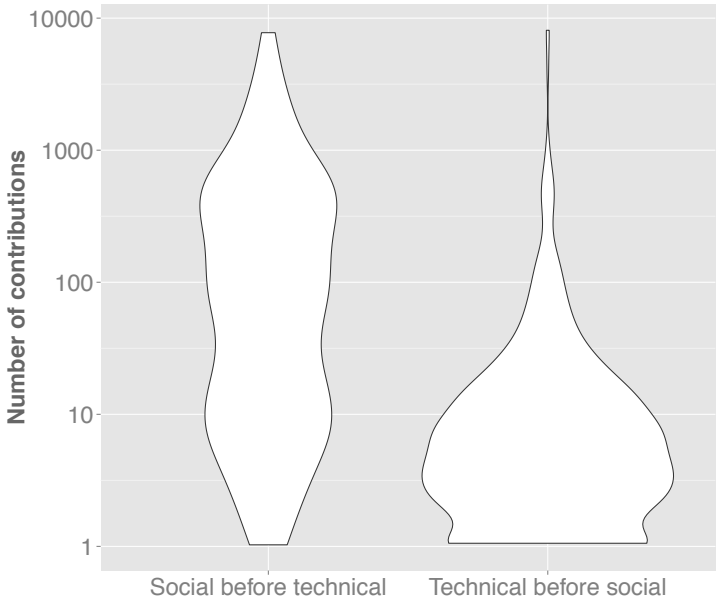
mostly < 10 contributions

Palyart and Murphy, 2015, under review

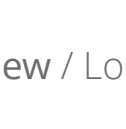
#2 - When do social contributions occur related to library use?







Palyart and Murphy, 2015, under review



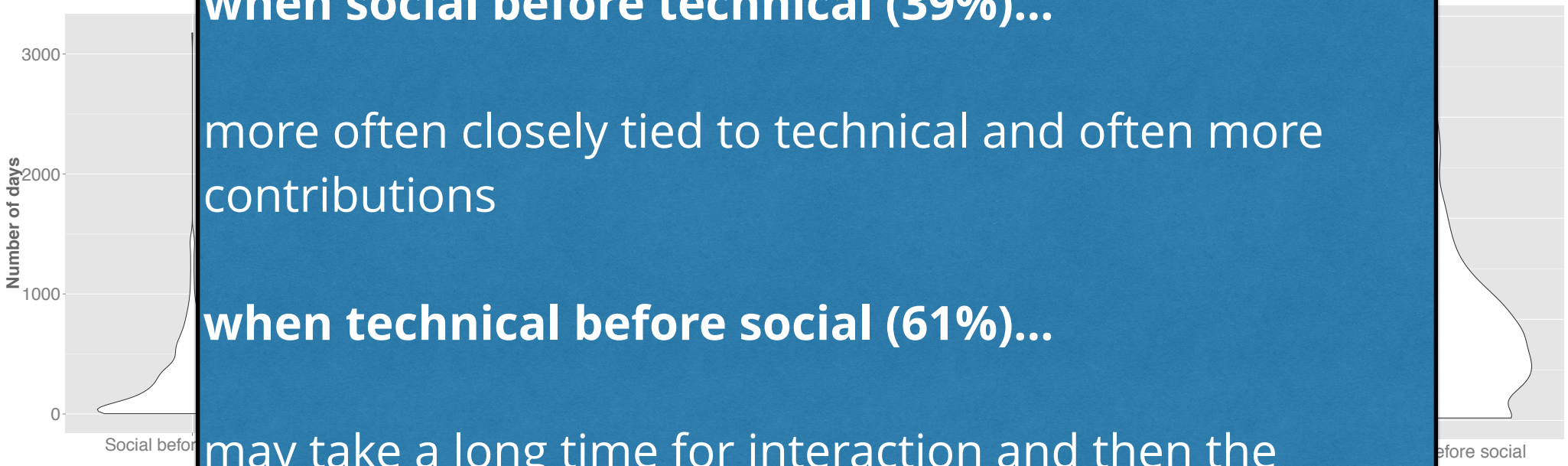
#2 - When do social contributions occur related to library use?

when social before technical (39%)...

more often closely tied to technical and often more contributions

when technical before social (61%)...

may take a long time for interaction and then the interactions are often quick

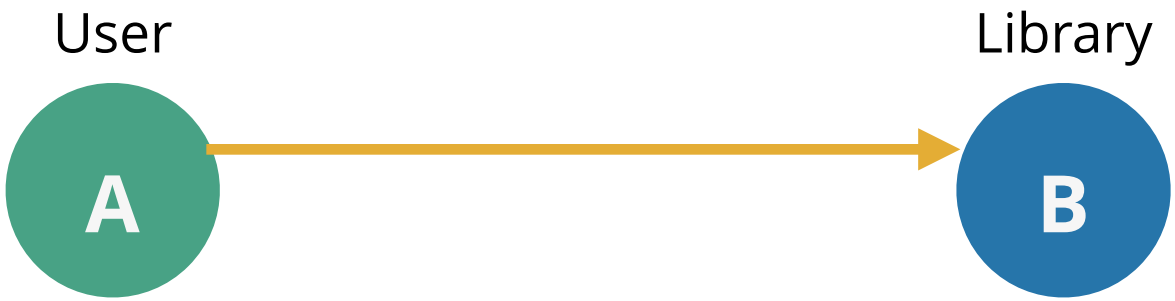


Palyart and Murphy, 2015, under review

#3 - What kind of social contributions occur?

Technical Link

Social Link



Palyart and Murphy, 2015, under review

#3 - What kind of social contributions occur?

Technical Link

Social Link

Palyart and Murphy, 2015, under review

#3 - What kind of social contributions occur?

Technical Link

Social Link

35% of pairs

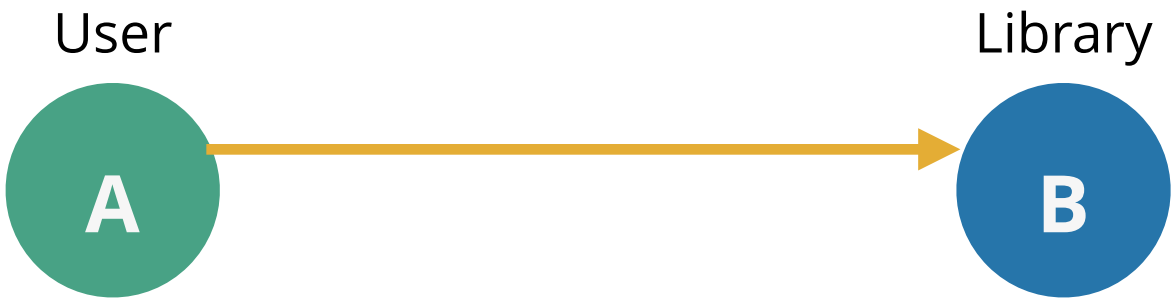
seeking help, feature requests, pull requests

Palyart and Murphy, 2015, under review

#3 - What kind of social contributions occur?

Technical Link

Social Link



Palyart and Murphy, 2015, under review

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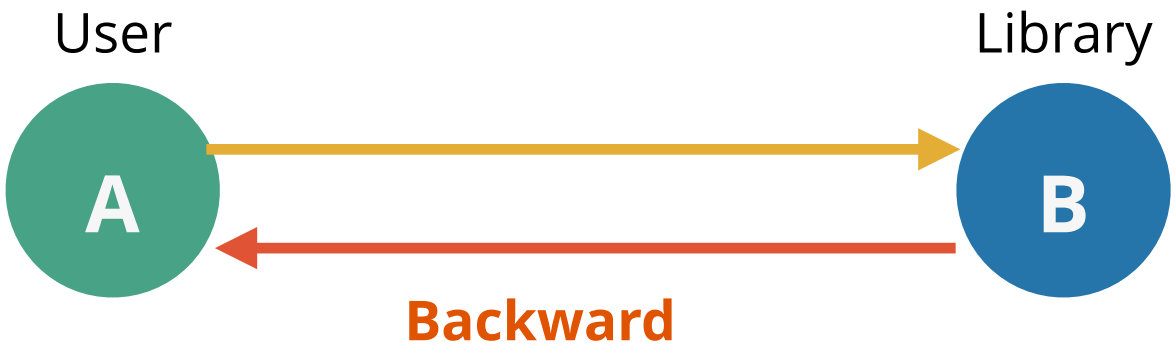
Technical Link

Social Link



Palyart and Murphy, 2015, under review

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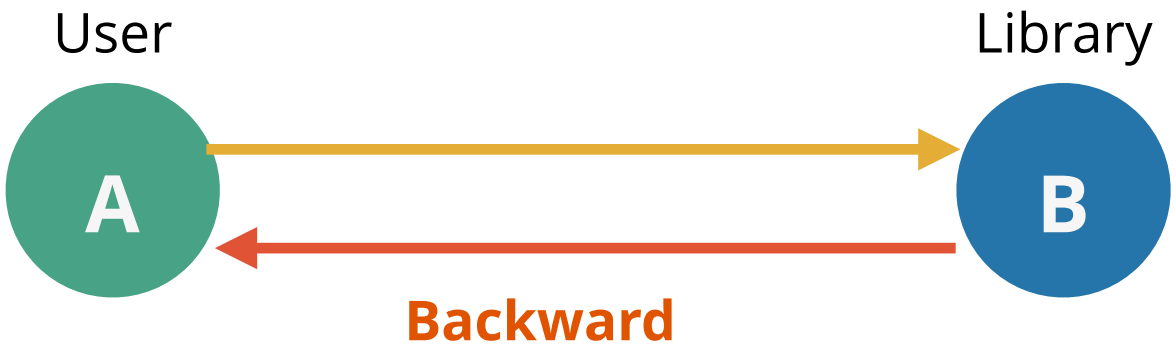
Technical Link

Social Link



30% of pairs

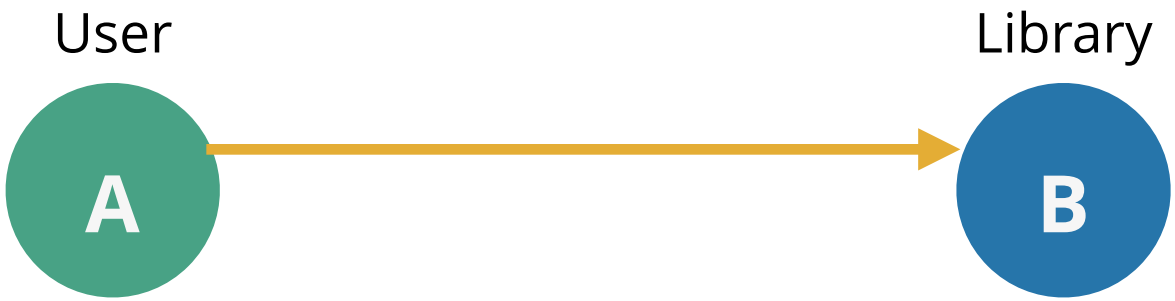
existing social community between projects

Palyart and Murphy, 2015, under review

#3 - What kind of social contributions occur?

Technical Link

Social Link



Palyart and Murphy, 2015, under review

#3 - What kind of social contributions occur?

Technical Link

Social Link

Palyart and Murphy, 2015, under review

#3 - What kind of social contributions occur?

Technical Link

Social Link

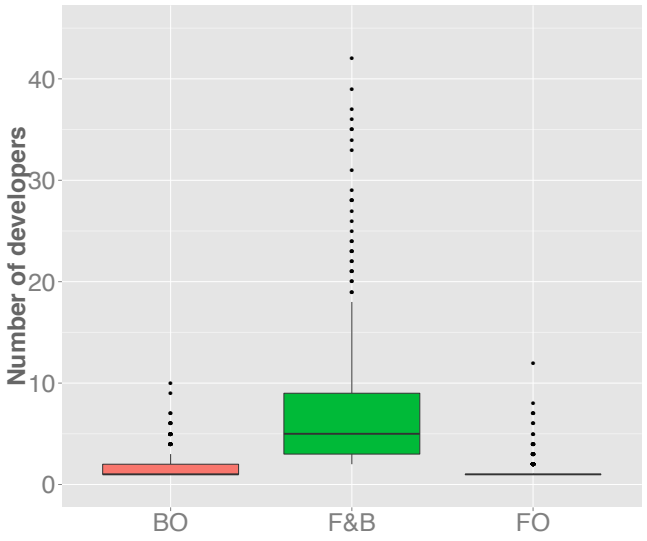
35% of pairs

user developers contribute to library
library developers later do pull-request to user project to update library

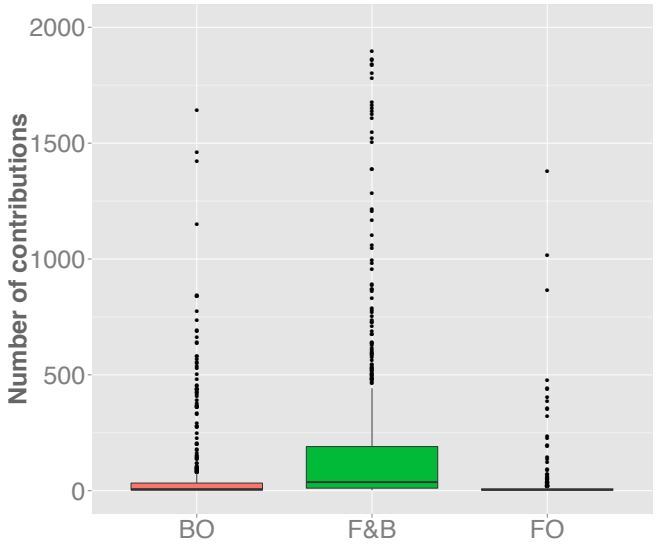
Palyart and Murphy, 2015, under review

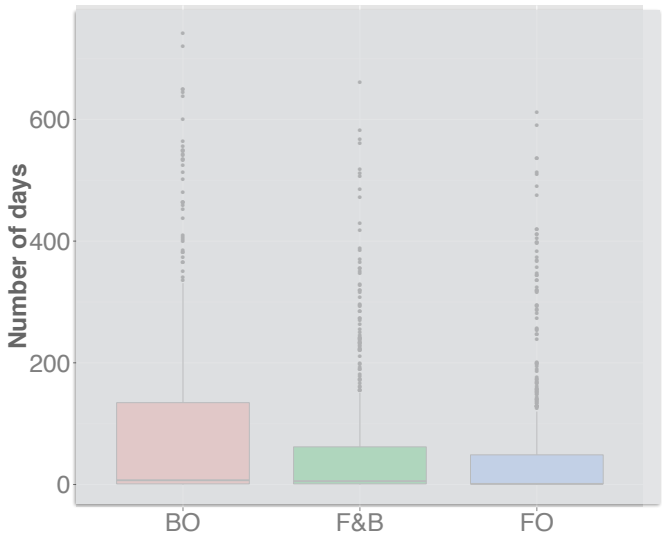
#3 - What kind of social contributions occur?

developers



social contributions





= backward only

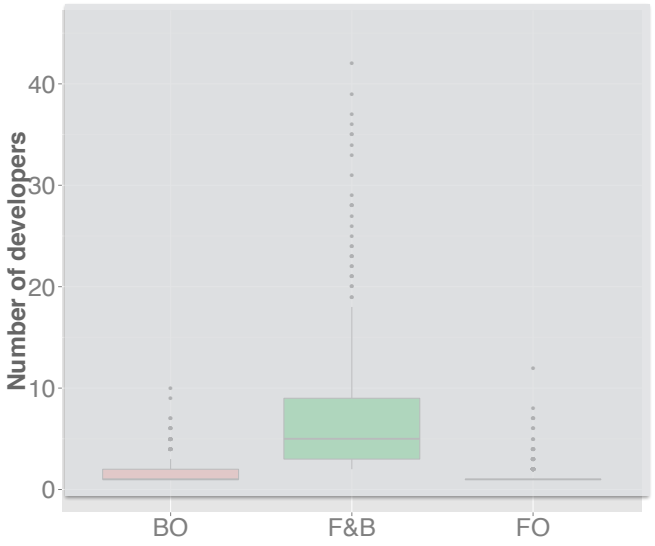
= forward & backward

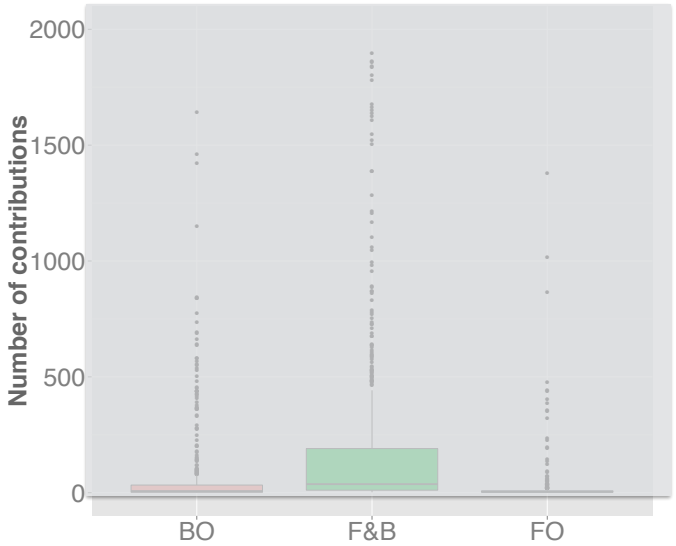
= forward only

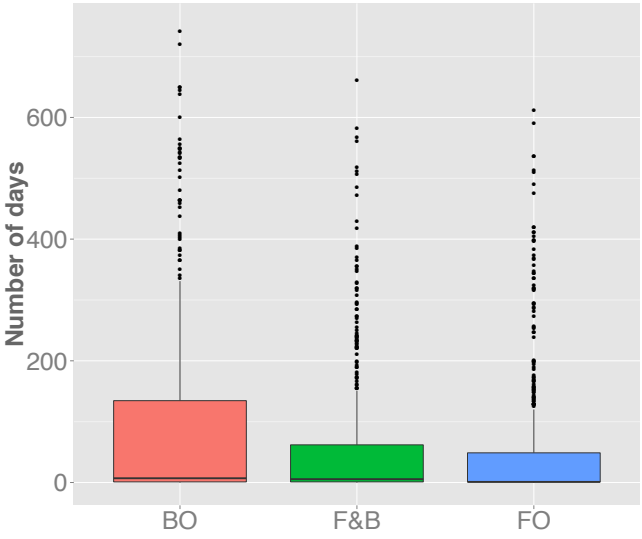
Palyart and Murphy, 2015, under review

#3 - What kind of social contributions occur?

involvement time







= backward only

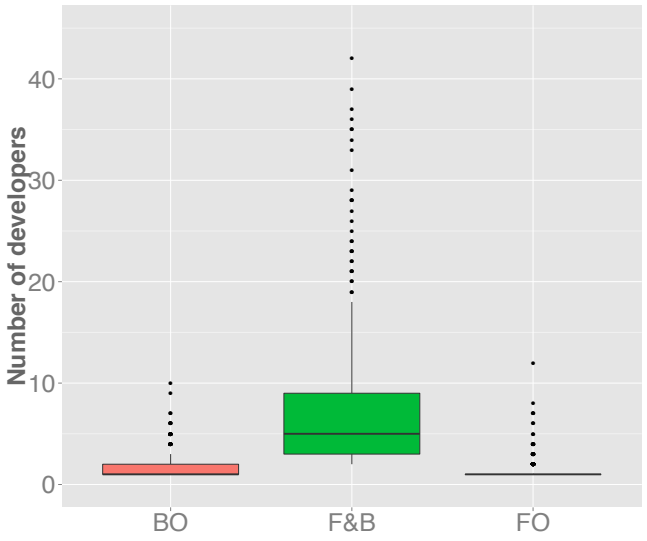
= forward & backward

= forward only

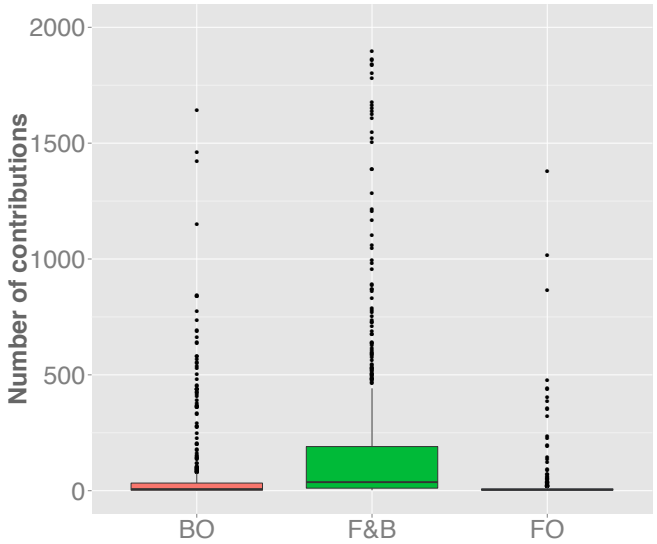
Palyart and Murphy, 2015, under review

#3 - What kind of social contributions occur?

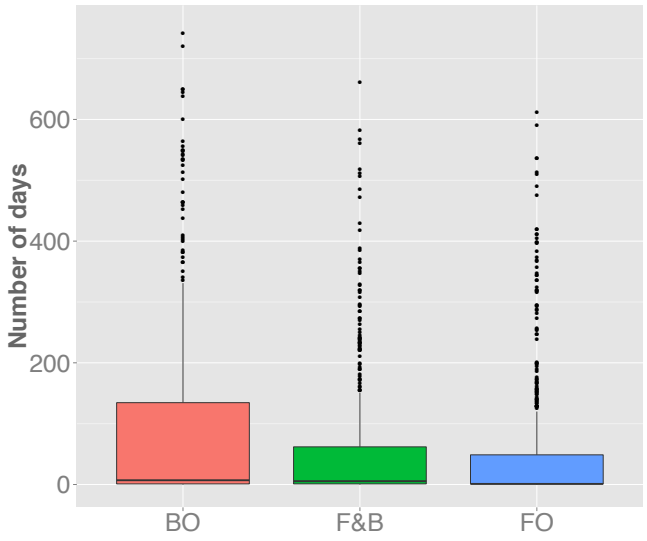
developers



social contributions



involvement time



= backward only

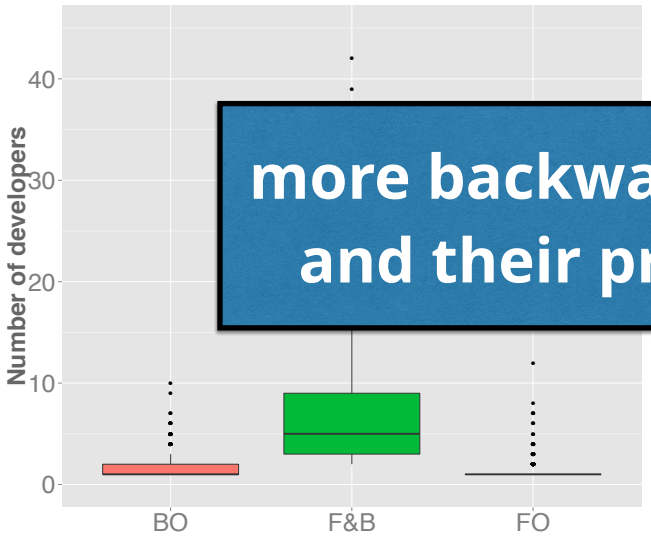
= forward & backward

= forward only

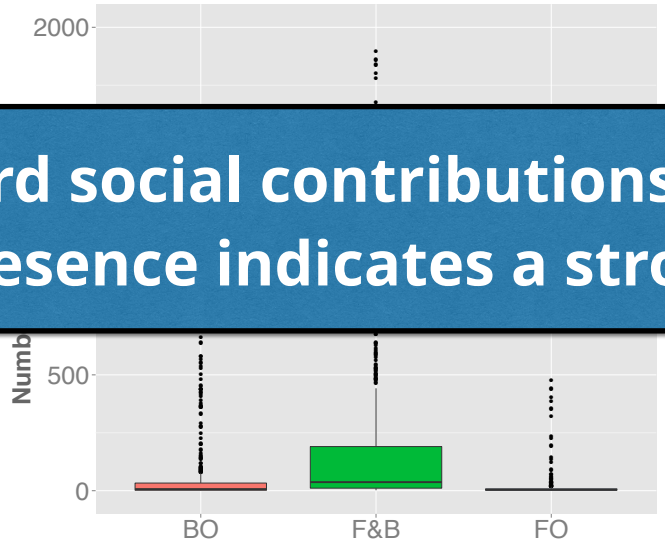
Palyart and Murphy, 2015, under review

#3 - What kind of social contributions occur?

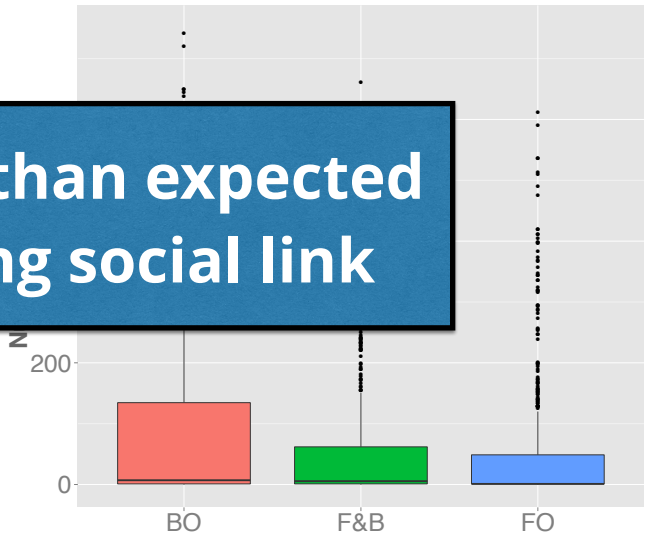
developers



social contributions



involvement time



more backward social contributions than expected and their presence indicates a strong social link

= backward only

= forward & backward

= forward only

Palyart and Murphy, 2015, under review

Loose Software Supply Chain

often a social cost to using a library

more often than expected cost to being a library

Two Parts

Social

Quality

Two Parts

Social

Quality

Quality Implications of OSS Library Use

2014: Central Repository of Java open source components

2015 State of the Software: Supply Chain Report (Sonatype)

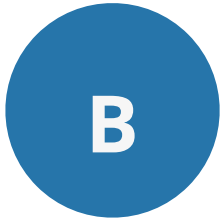
Quality Implications of OSS Library Use

constant updating
~ 3.5 times / yr

2014: Central Repository of Java open source components

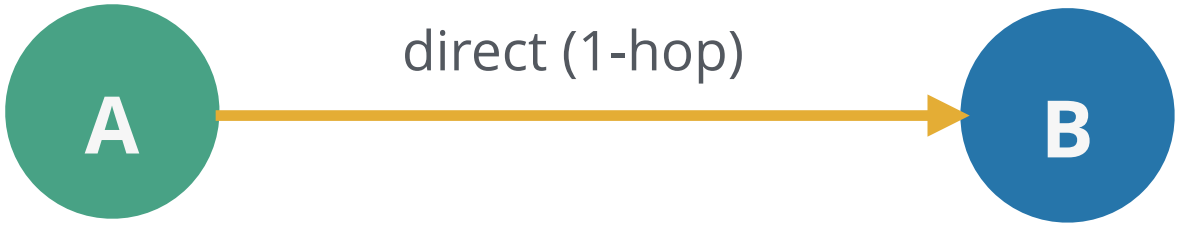
2015 State of the Software: Supply Chain Report (Sonatype)

Quality Implications of OSS Library Use



Almost too Big to Fail, Geer and Corman, USENIX 2014

Quality Implications of OSS Library Use



Almost too Big to Fail, Geer and Corman, USENIX 2014

Quality Implications of OSS Library Use

Almost too Big to Fail, Geer and Corman, USENIX 2014

Quality Implications of OSS Library Use

only **41%** of vulnerable dependencies remediated

Almost too Big to Fail, Geer and Corman, USENIX 2014

Quality Implications of OSS Library Use

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mean-time-to-repair of these was 390 days

Almost too Big to Fail, Geer and Corman, USENIX 2014

Quality Implications of OSS Library Use

only **41%** of vulnerable dependencies remediated

mean-time-to-repair of these was 390 days

CVSS level 10 - still 224 days to repair

Almost too Big to Fail, Geer and Corman, USENIX 2014

Quality Implications of OSS Library Use

CVE-2013-2251
CVSS 9.3
Exploitability 10

since identification...

4,076 organizations have downloaded the vulnerable component **179,050** times

2015 State of the Software: Supply Chain Report (Sonatype)

Quality Implications of OSS Library Use

The Legion of the Bouncy Castle

CVE-2007-6721
CVSS 10
Exploitability 10

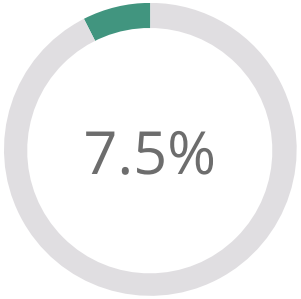
since identification...

11,236 organizations have downloaded the vulnerable component **214,484** times

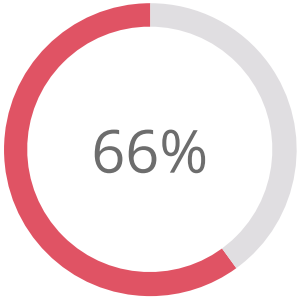
2015 State of the Software: Supply Chain Report (Sonatype)

Quality Implications of OSS Library Use

of 240,757 component downloads by large financial or technology firms in 2014...



were of known defective part



and or those with a defective part, the defects were older than 2013

2015 State of the Software: Supply Chain Report (Sonatype)

Loose Software Supply Chain

(re)use is not free

social and upgrade costs to use

Photo copyright Gniot/Shutterstock

Reality View:

Tight Supply Chain

Two Parts

Two Parts

Social

Two Parts

Social

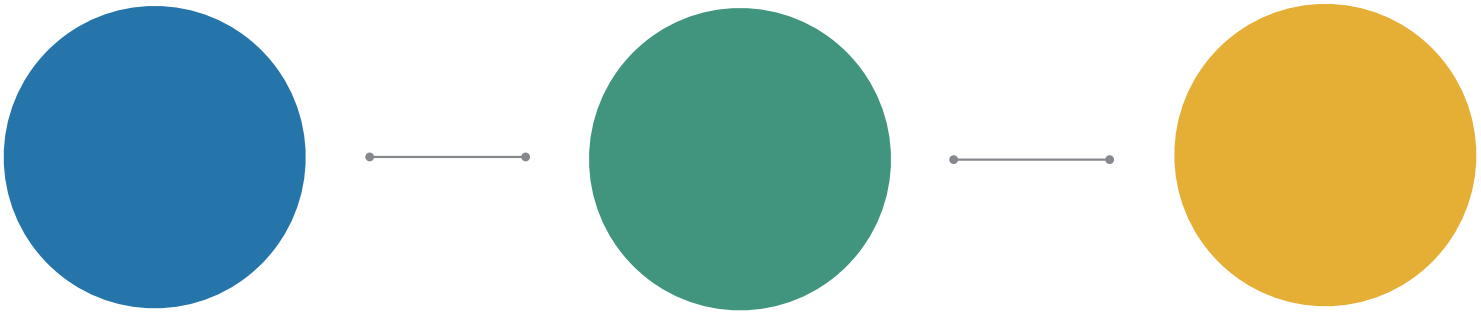
Quality

Two Parts

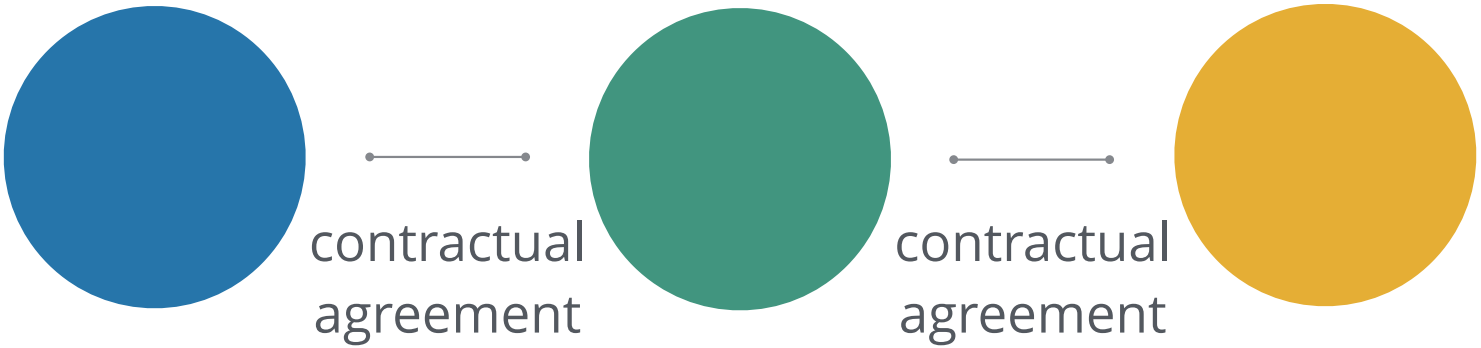
Social

Quality

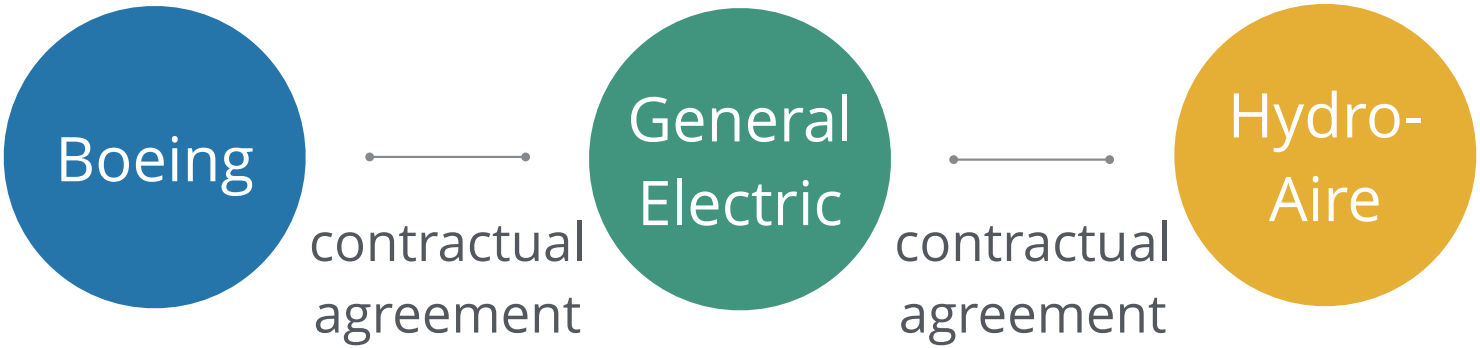
Tight Software Supply Chain



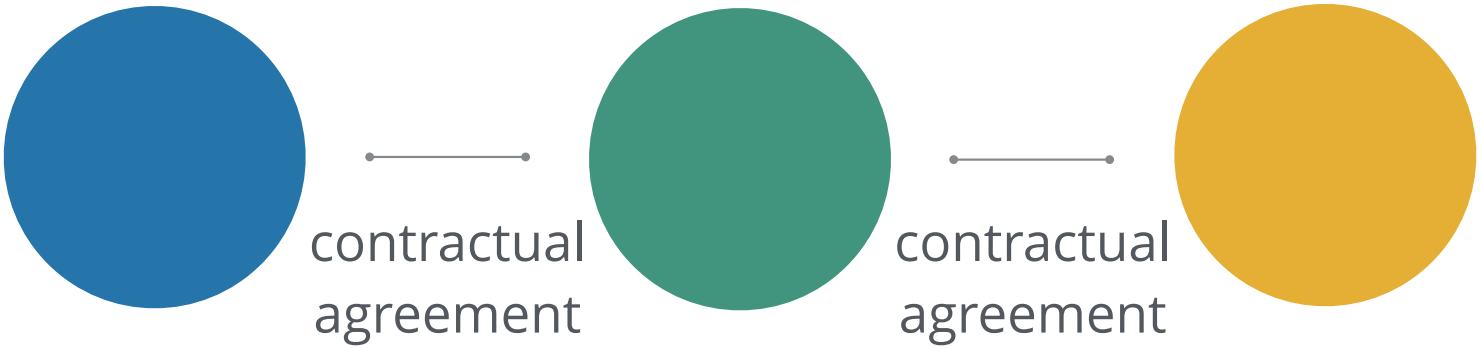
Tight Software Supply Chain



Tight Software Supply Chain



Communication



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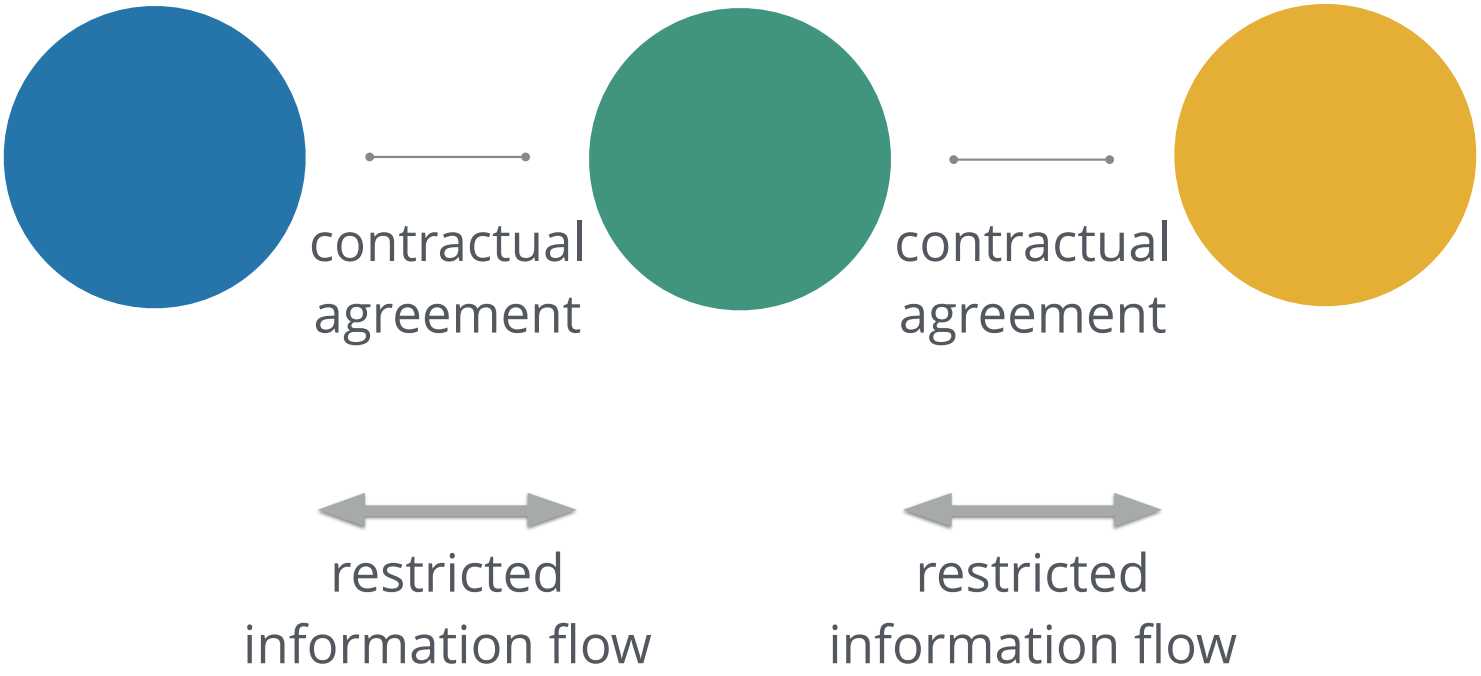

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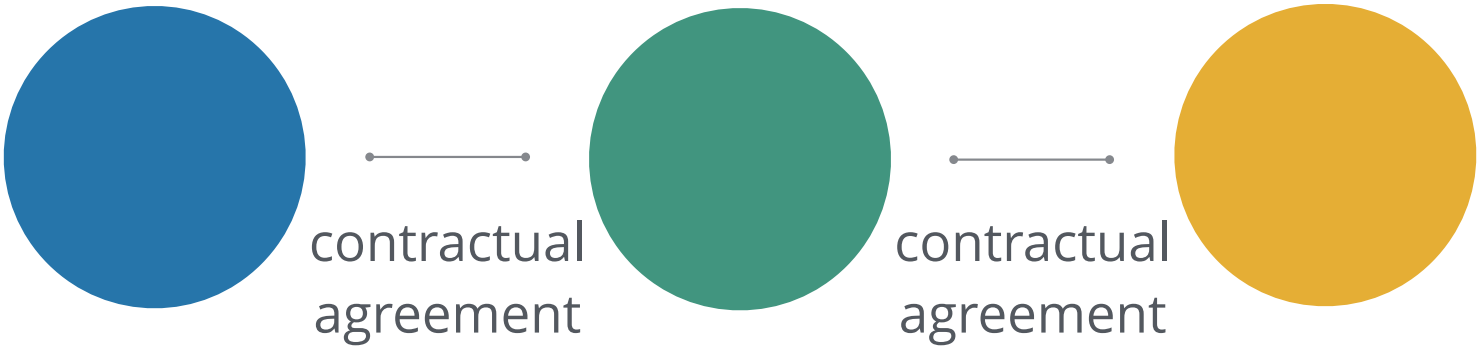

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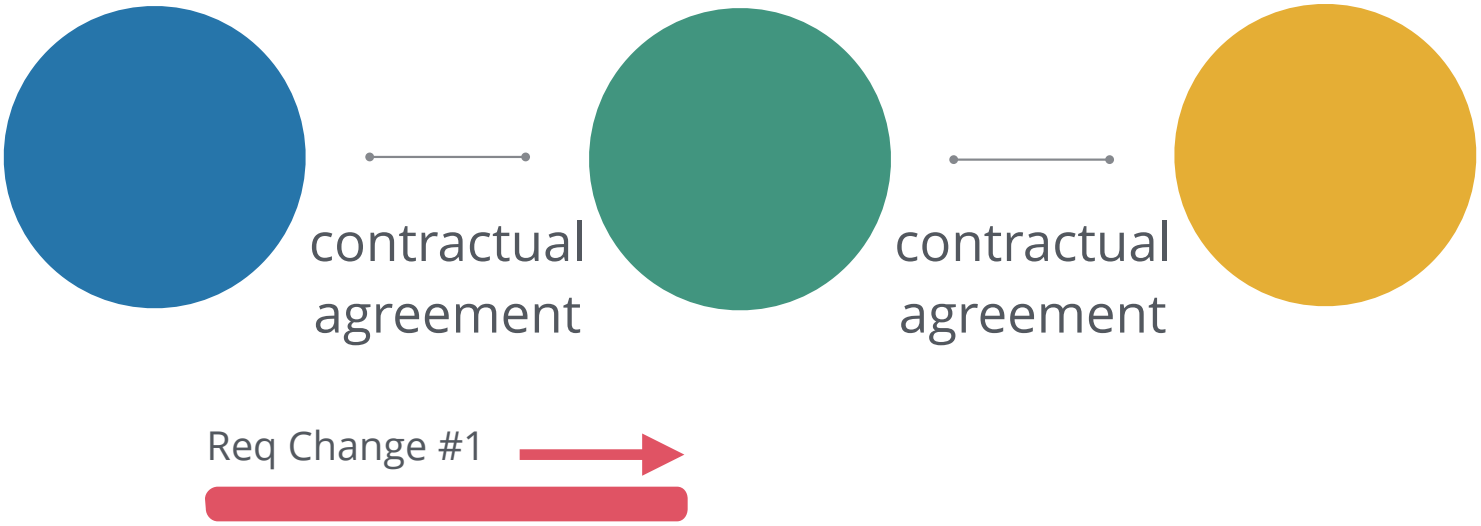

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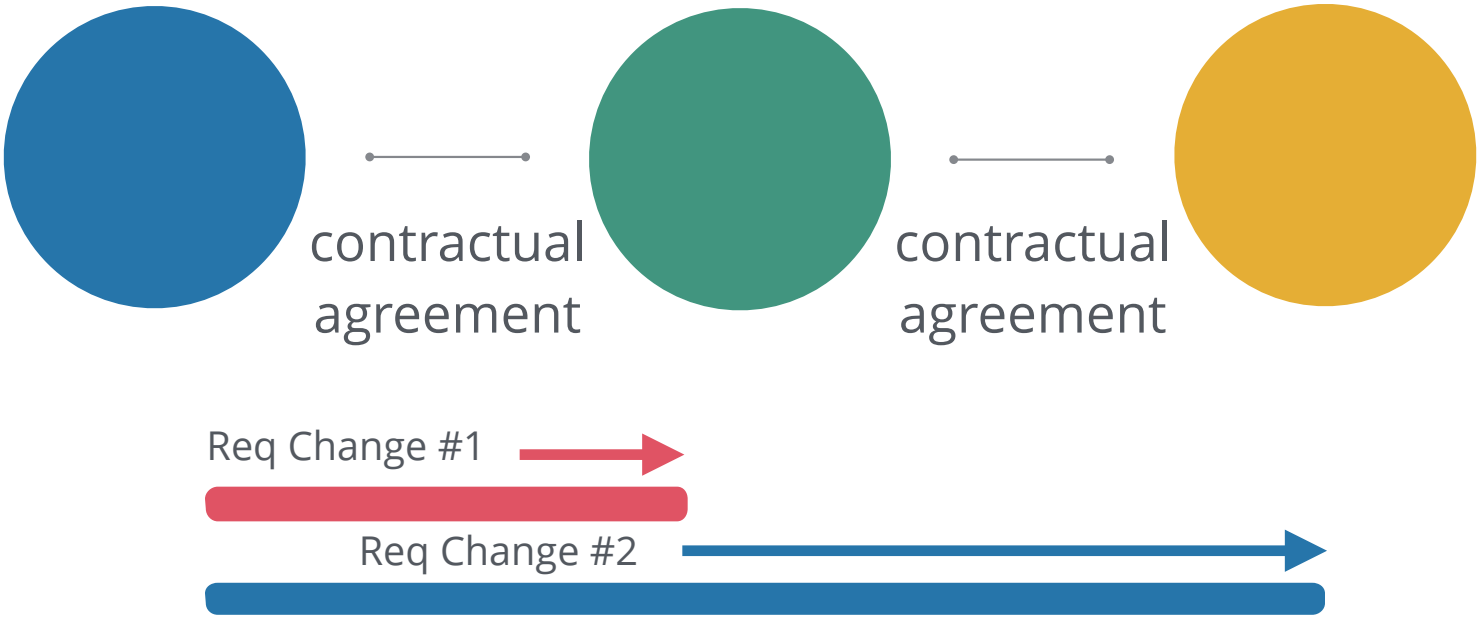

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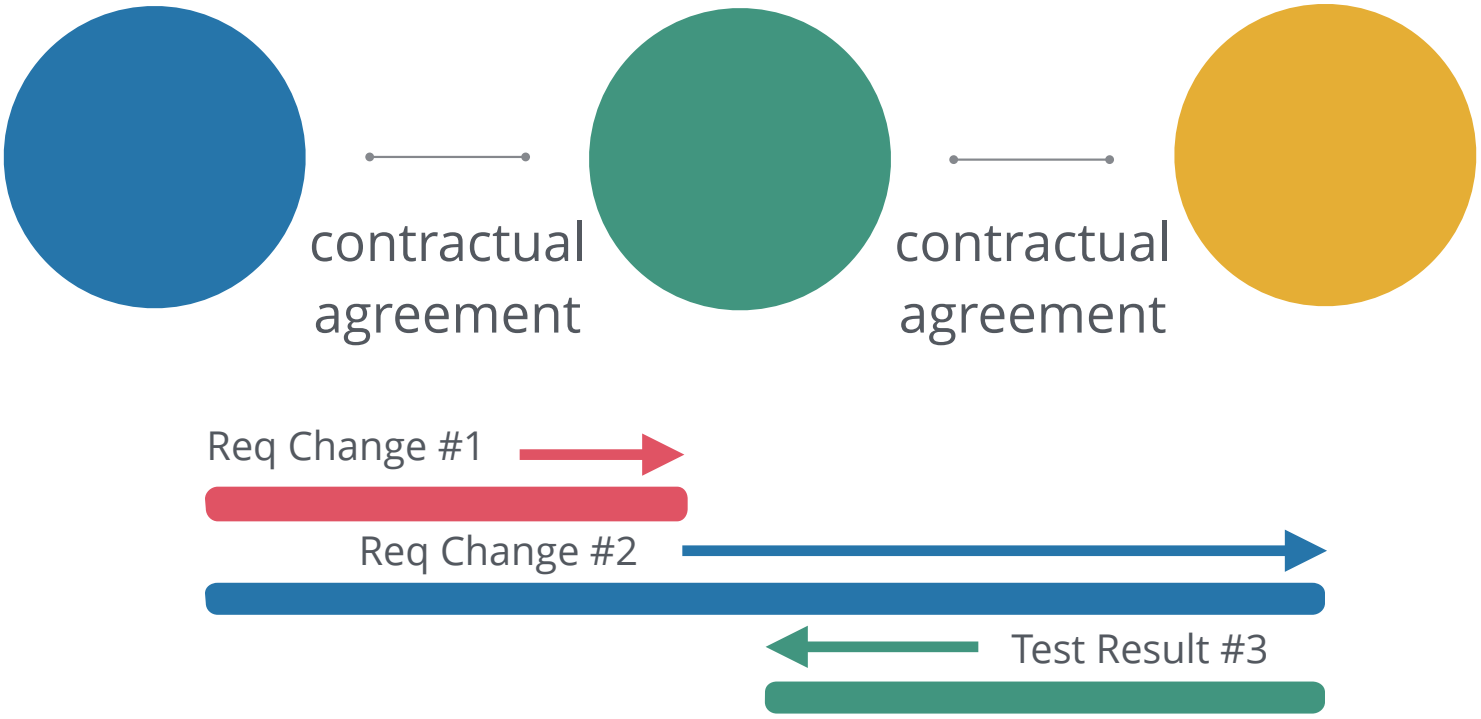

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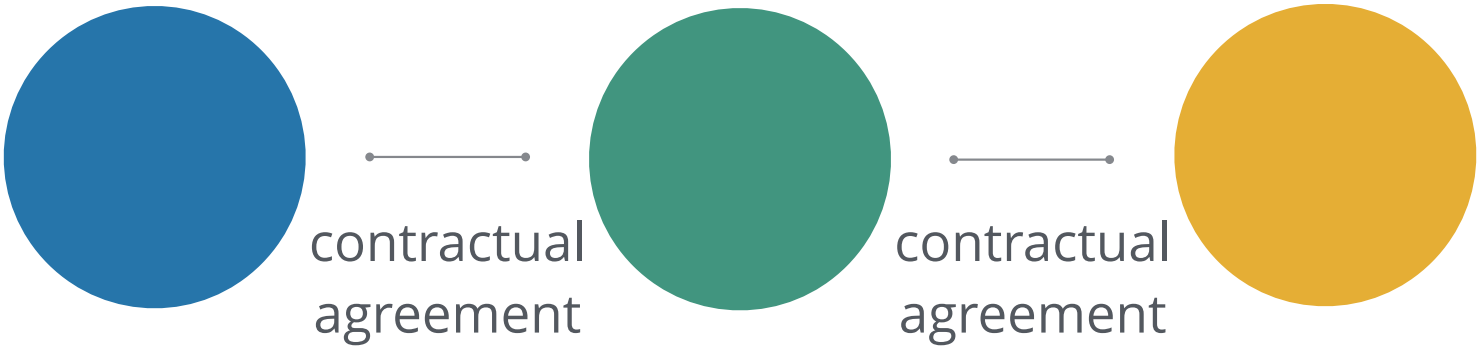

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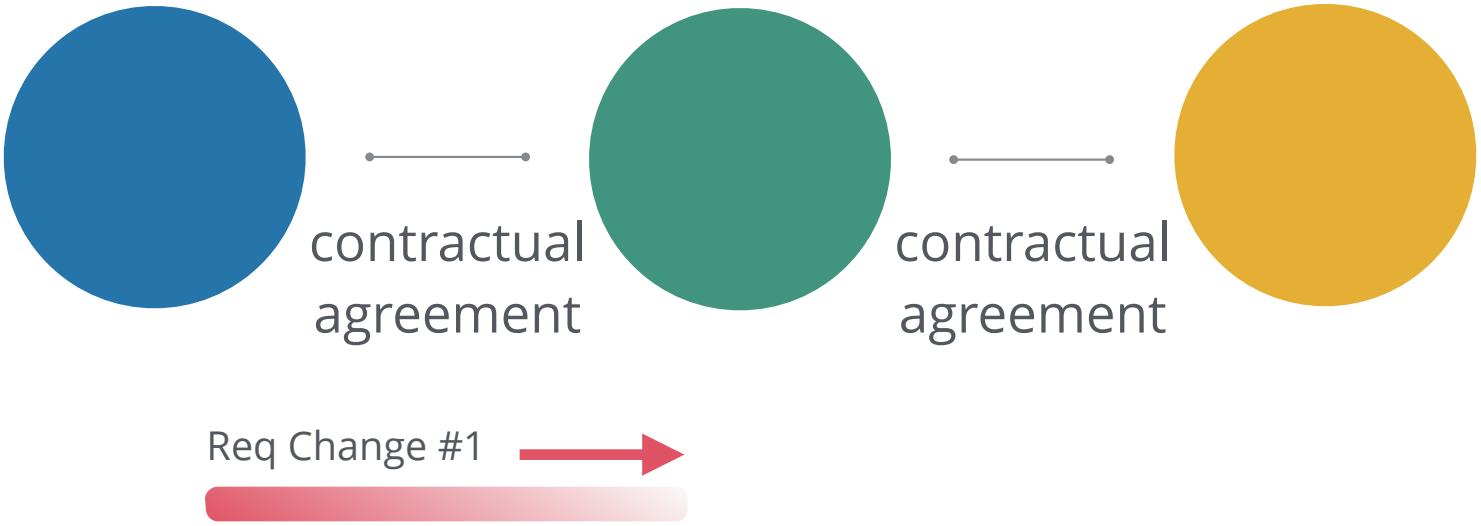

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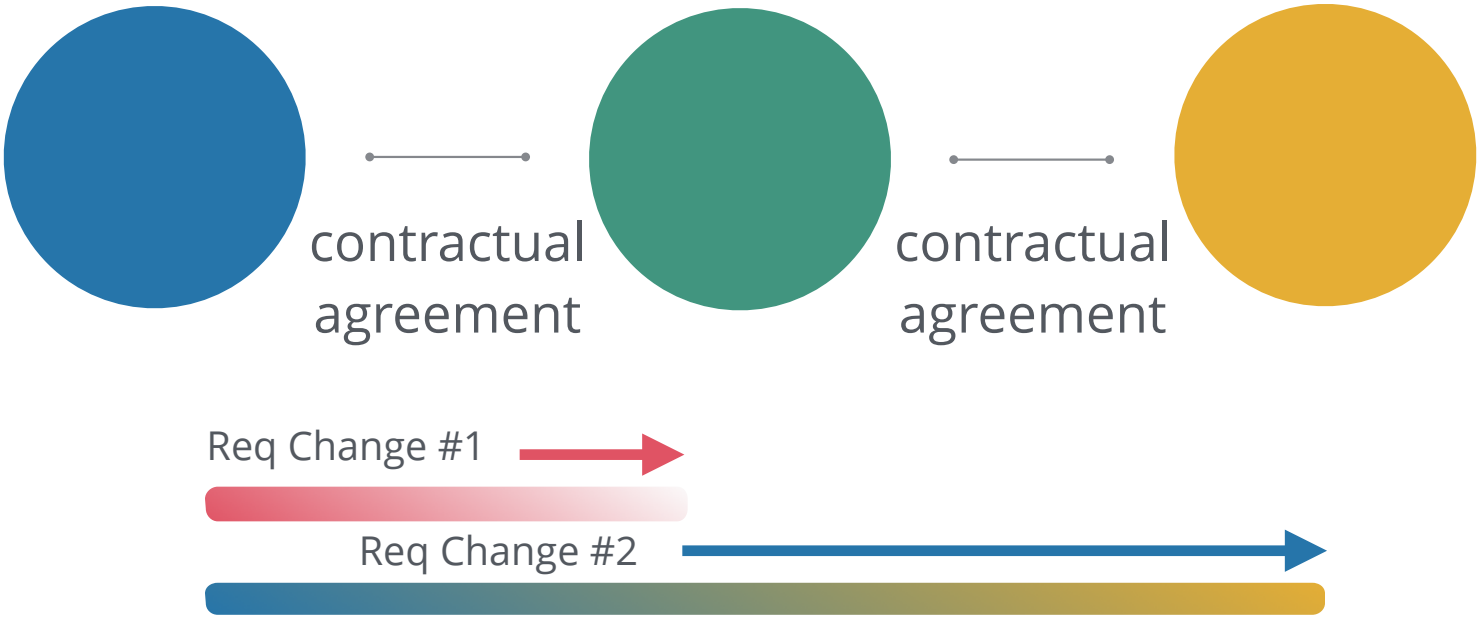

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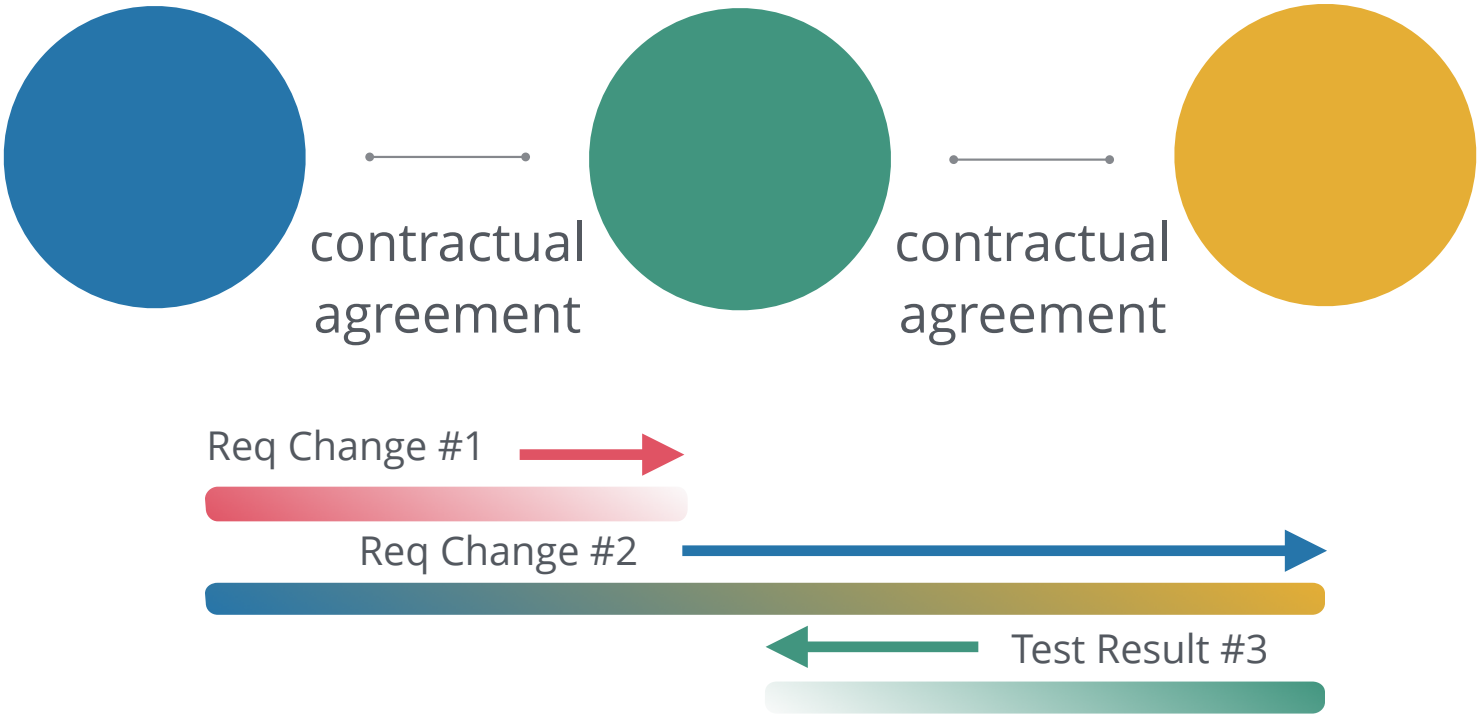
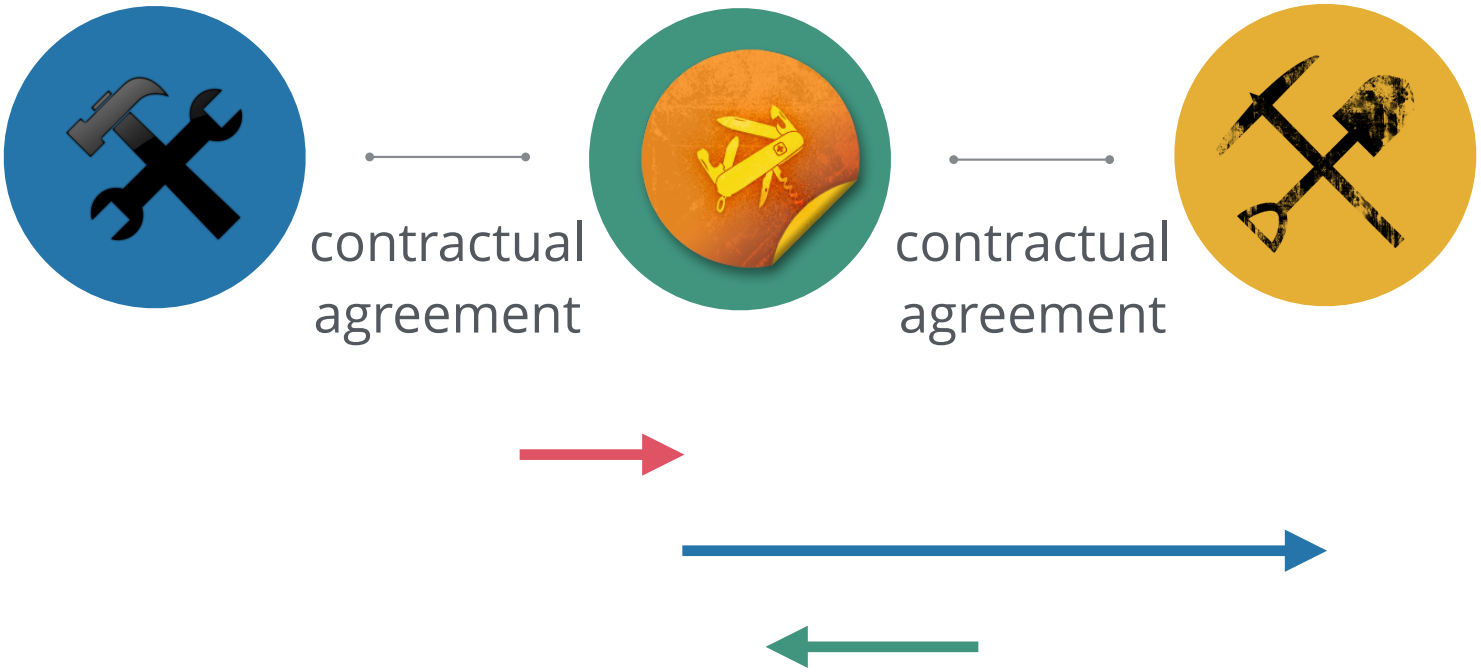


Communication



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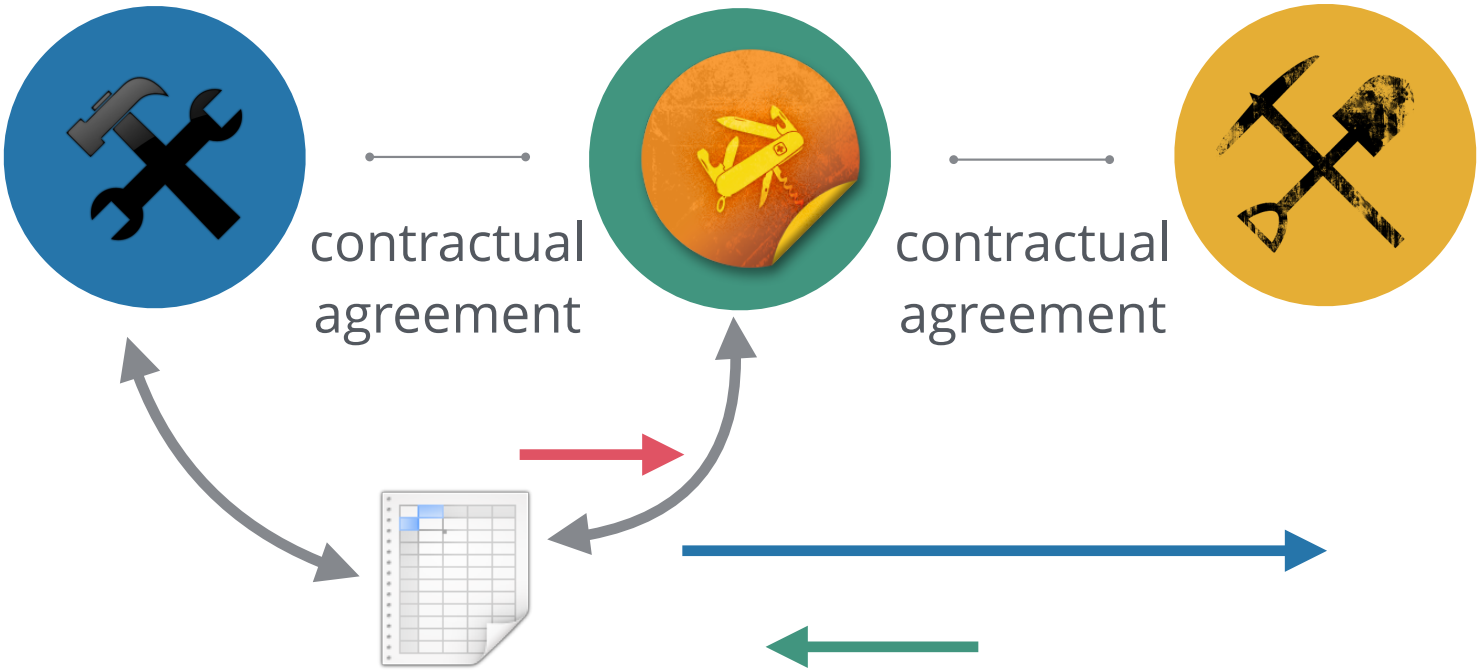

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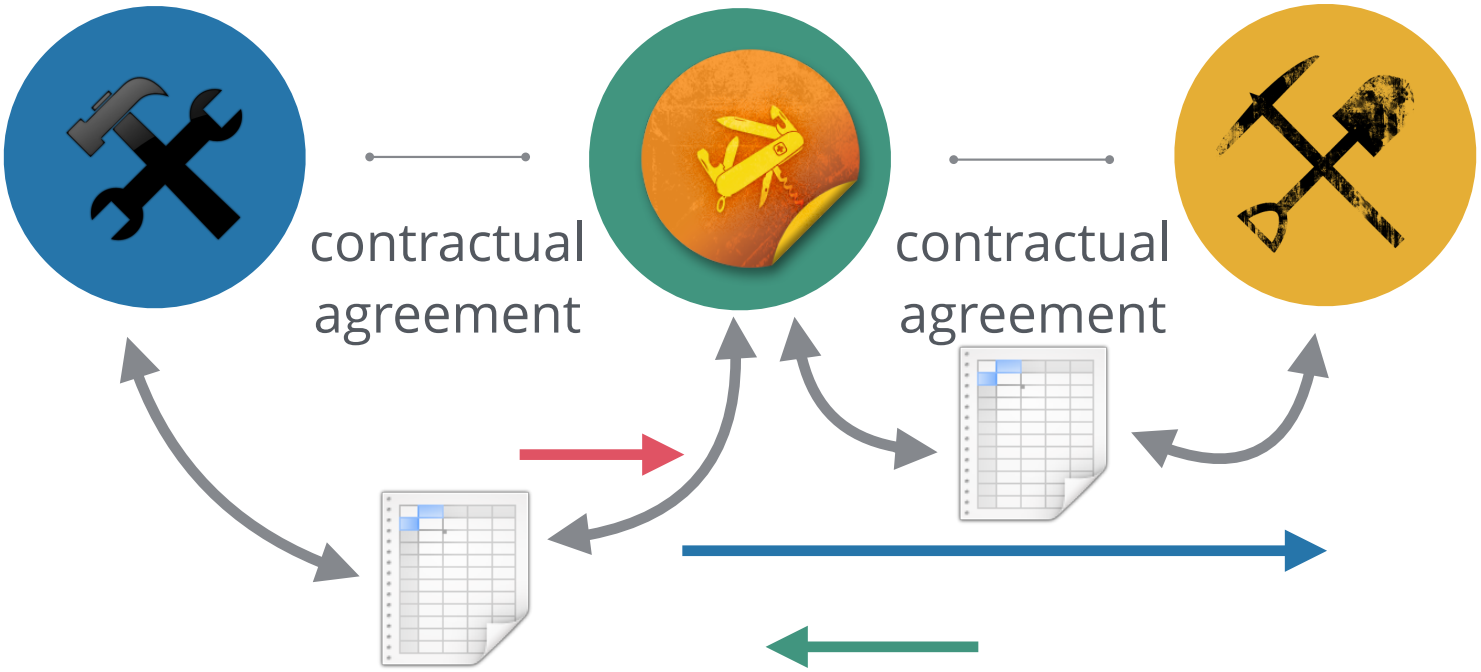


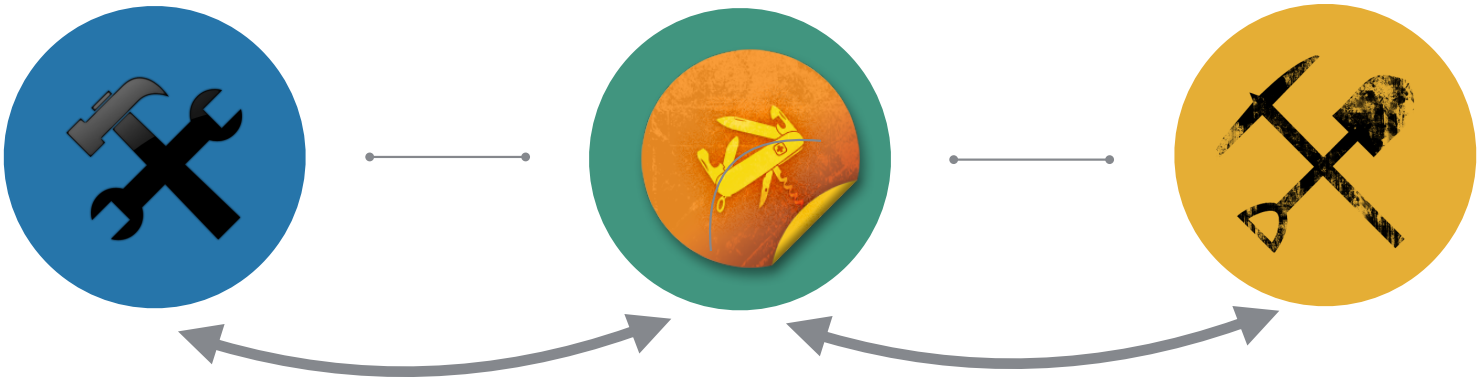
Communication

Doors
RTC
HP Quality Center

Blueprint
RTC
HP Quality Center

VersionOne
Eclipse
HP Quality Center

Communication



Doors
RTC
HP Quality Center

Schema Mappings

Blueprint
RTC
HP Quality Center

Schema Mappings

VersionOne
Eclipse
HP Quality Center

TASKTOP SYNC

Tight Software Supply Chain

need tools to facilitate
appropriate communication

Two Parts

Social

Quality

Two Parts

Social

Quality

Tight Software Supply Chain

Boeing — General Electric — Hydro-Aire

ability to verify the brake software wasn't built in

Tight Software Supply Chain

Boeing — General Electric — Hydro-Aire

~~full transparency~~
~~full opacity~~

Tight Software Supply Chain

controlled transparency

balance need to share with
protection of intellectual property

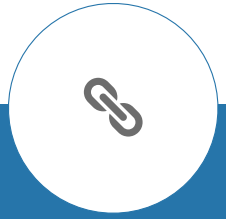
Open Problems

Loose Software Supply Chains

can we....

measure and predict social cost of component use?

determine when backward social contributions are needed?



assess when a component upgrade is needed?

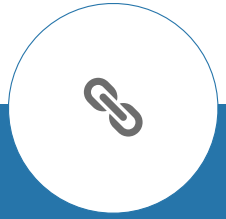
lower the cost of quality and security upgrades?

Tight Software Supply Chains

can we....

automatically apply IP filters to information exchange?

provide white-box information without revealing secret sauce?



cost-effectively manage multi-tiered supply chains?

effectively handle arrangements of tight and loose supply chains?

Summary

Marc Palyart

Mik Kersten

Dave West

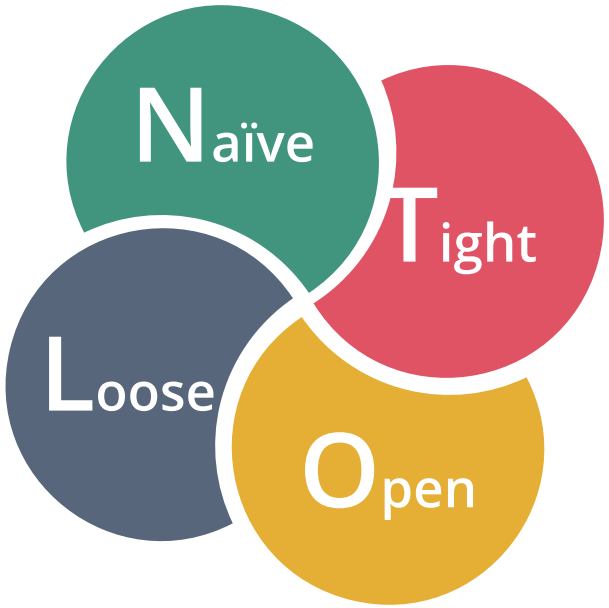
Thanks to many post-docs, students and industrial collaborators over the years for their insights.

Thanks to NECSIS colleagues (particularly Jo Atlee, Marsha Chechik and Mark Lawford) for conversations.

Thanks to Sonatype for an analysis of the Central Repository.

Software Supply Chains

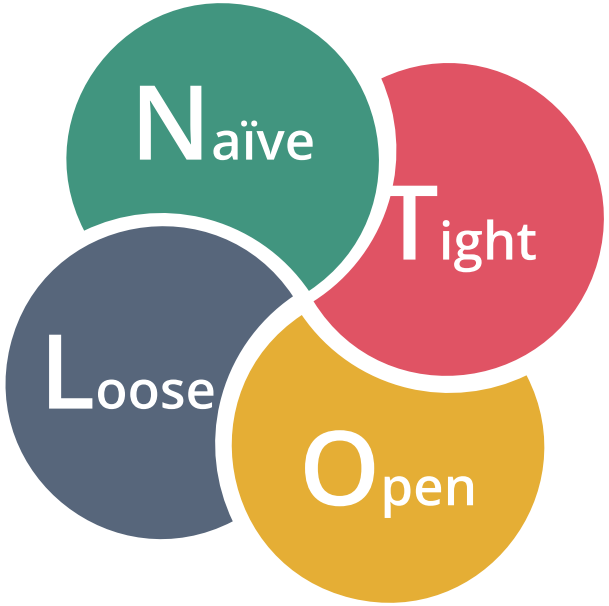
Software Supply Chains



Software Supply Chains

Naïve

Better, faster, cheaper



Tight Supply Chain

Controlled transparency

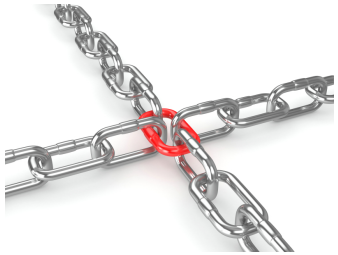
Loose Supply Chain

Reuse is not free

Open Problems

Technical and ecosystem

Loose — Software Supply Chains — Tight



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"supply chain" conjures up thoughts of organized, managed flows

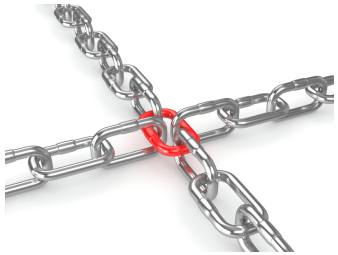
for software supply chains, the reality is different (chaotic? brittle?)

(re)use is not free

controlled transparency

@gail_murphy

Loose — Software Supply Chains — Tight



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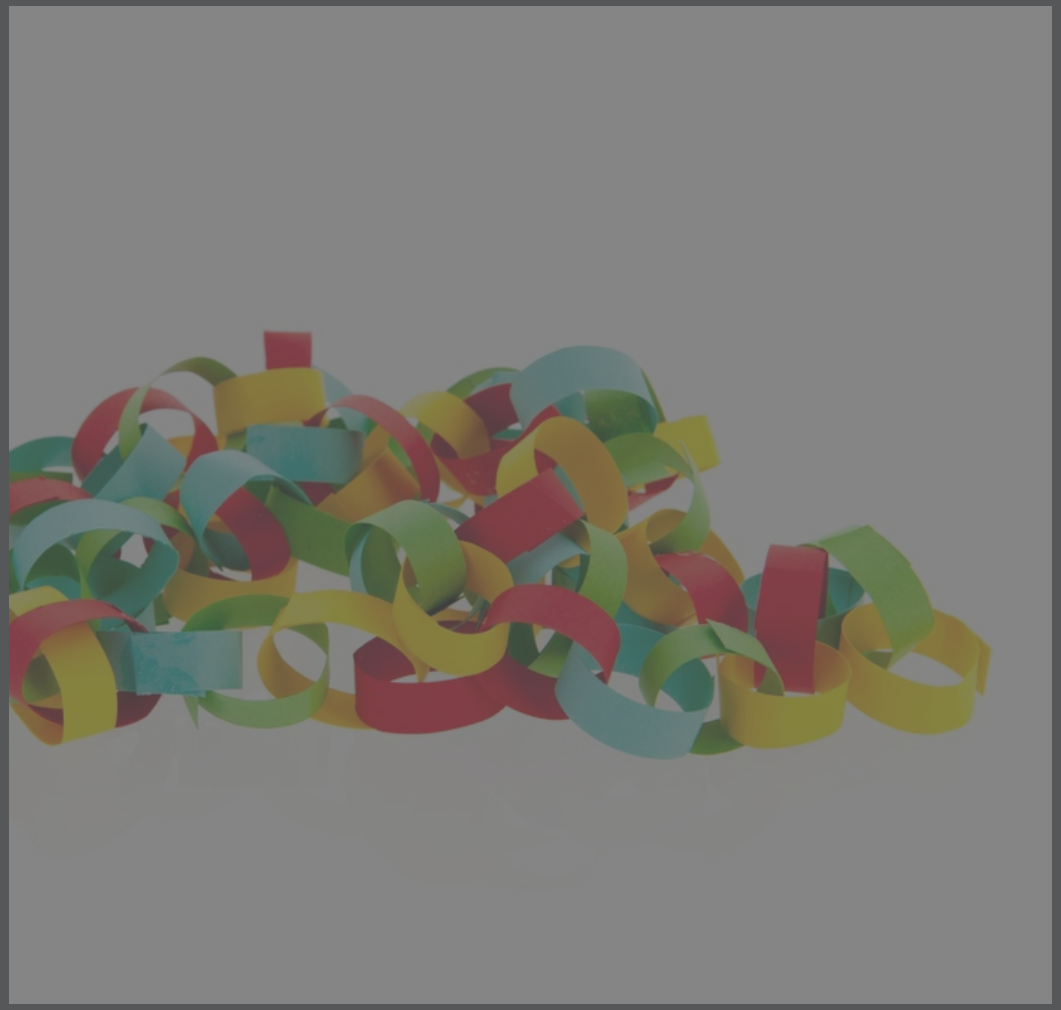

Software Supply Chains

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