goto; copenhagen

GOTO Copenhagen 2019
Conference Nov. 18 - 20

USING **GRAPH THEORY** & **NETWORK SCIENCE** TO EXPLORE YOUR MICROSERVICES ARCHITECTURE

Nicki Watt - CTO
@techiewatt

OpenCredo
A TRIFORK COMPANY

goto; copenhagen

GOTO Copenhagen 2019

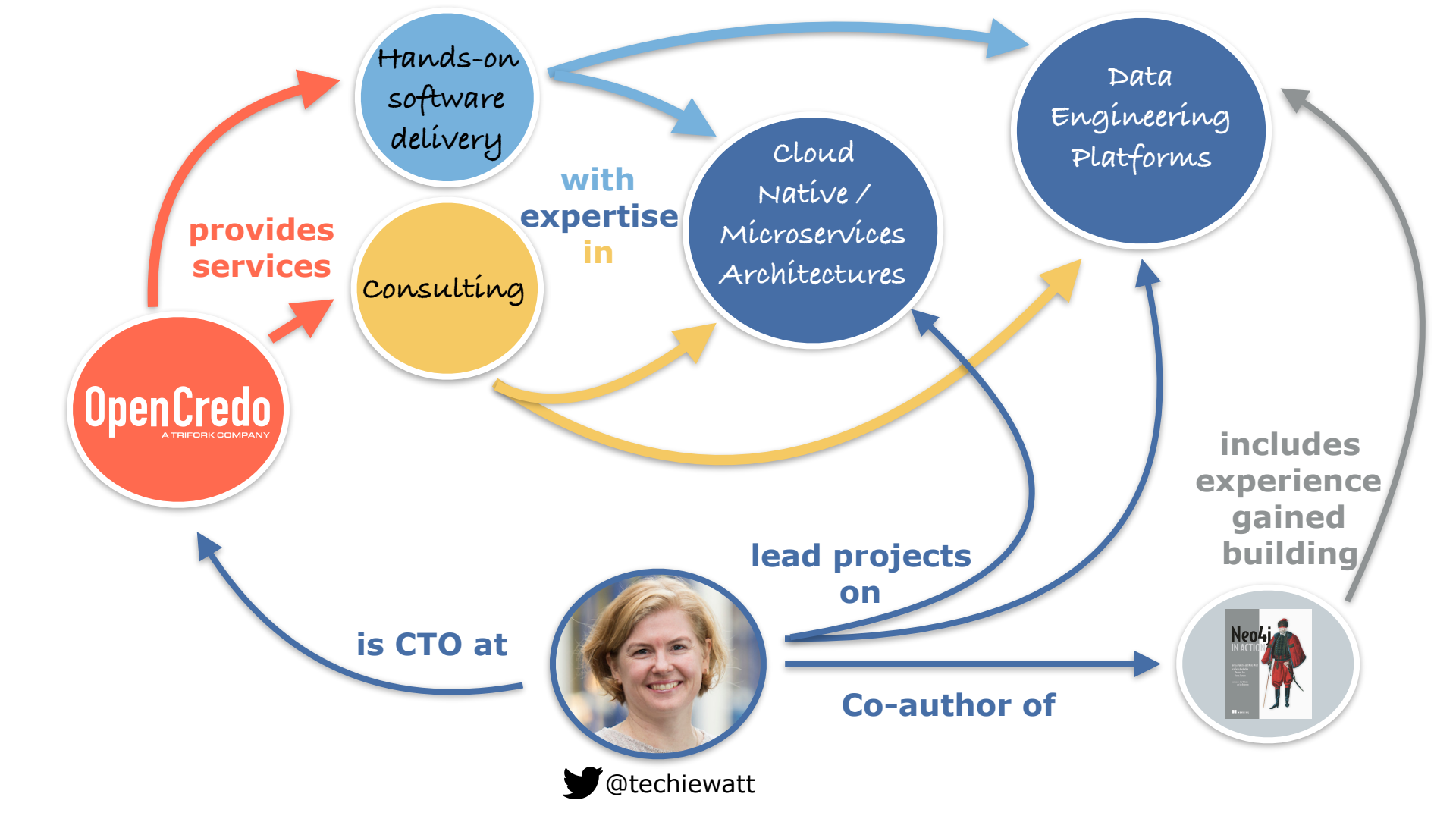
Conference Nov. 18 - 20

Please

Remember to rate this session

Thank you!

Follow us @gotocph


Hands-on software delivery
Data Engineering Platforms
with expertise in
Cloud Native / Microservices Architectures
provides services
Consulting
OpenCredo
A TRIFORK COMPANY
includes experience gained building
lead projects on
is CTO at
Co-author of
Neo4j IN ACTION
@techiewatt

AGENDA
OVERVIEW

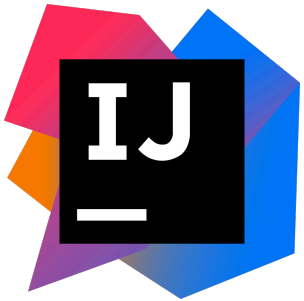
- INTRO & HYPOTHESIS
- A BIT OF THEORY
- MICROSERVICE EXPLORING
- SUMMARY

INTRODUCTION

INTRODUCTION

Graph theory is already being used to drive efficiencies in, and produce more reliable software systems

INTRODUCTION

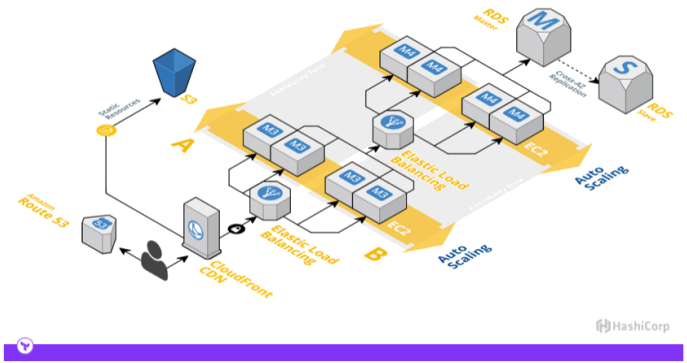


Code: Analysing software package & license dependencies

INTRODUCTION

Credit: Paul Hinze (HashiConf 2016)
Applying Graph Theory to Infrastructure-as-code

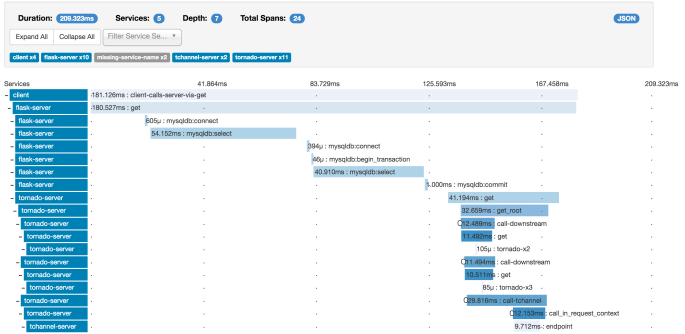
Terraform



Infrastructure: Reliably managing and updating cloud and other infrastructure-as-code resources

@techiewatt

INTRODUCTION



Ops & Monitoring:
Troubleshooting, Distributed Tracing & Latency analysis

@techiewatt

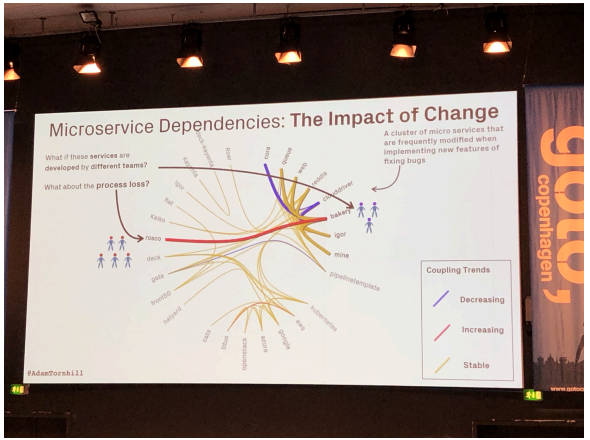
INTRODUCTION

Can we also use it to help inspect and drive us towards improvements in our microservices architecture?

#GOTOcph SHOUT OUT!

In microservice architectures, the most important aspects are not properties of the code but properties of the system

- Adam Tornhill



@techiewatt

HYPOTHESIS

HYPOTHESIS

General Hypothesis:
Data Driven Architectural Improvement

You can extract metrics and KPIs from a microservices architecture using graph theory
AND
use these to gain insight into the structure and characteristics of your microservices architecture

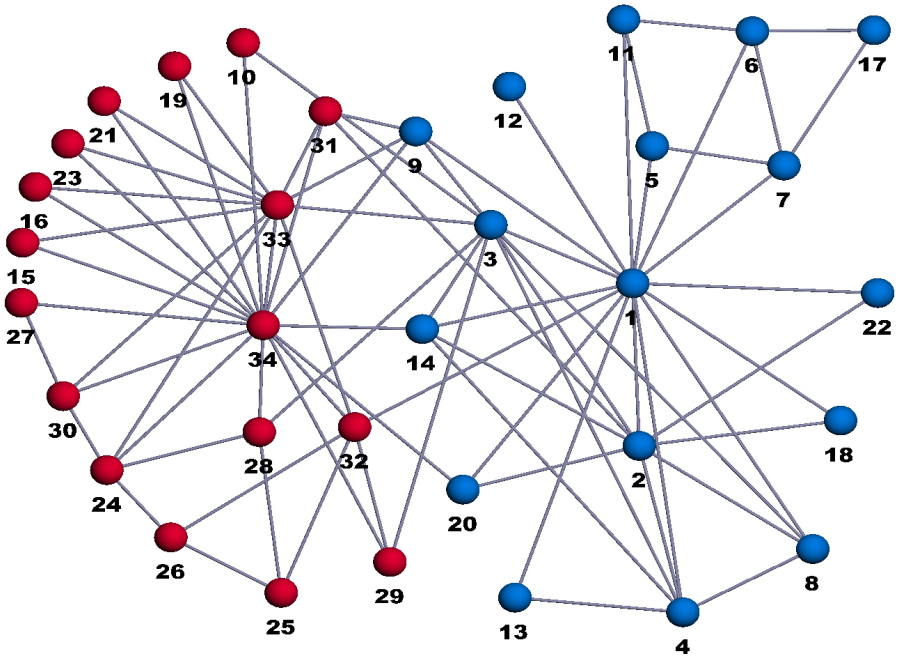

@techiewatt

HYPOTHESIS

For this talk ...

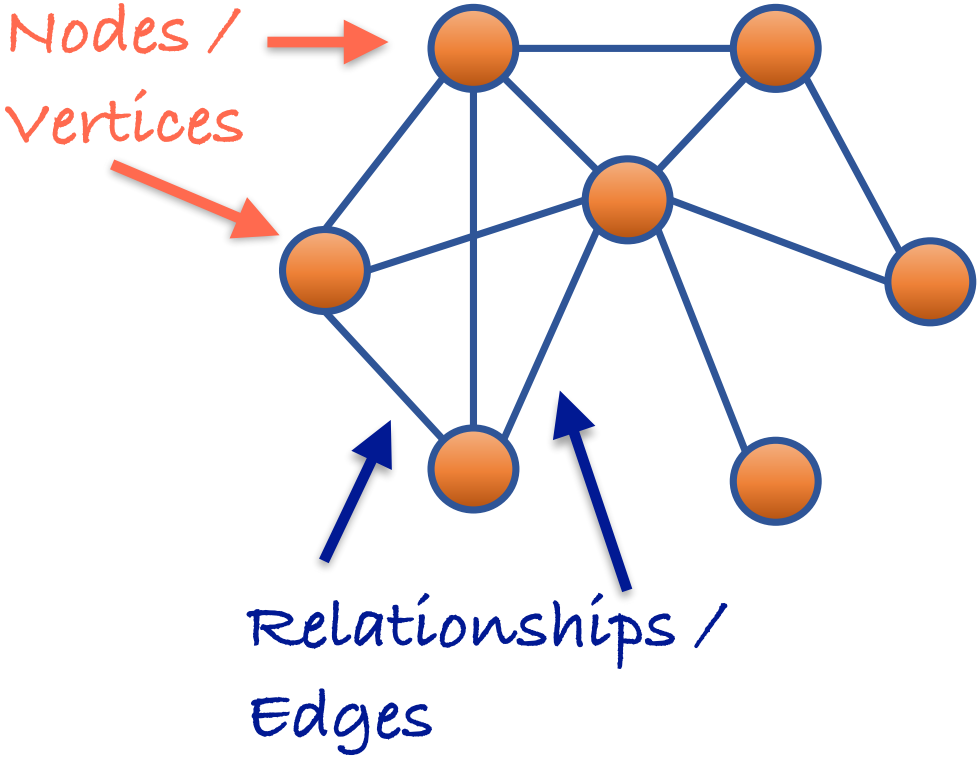
Can we use these metrics to detect bad microservice architectural smells and anti-patterns like a tightly coupled architecture (distributed monolith)

A QUICK BIT OF THEORY



@techiewatt

GRAPH THEORY 101



A graph is a way to formally represent a network, or collection of related objects, in a mathematical way

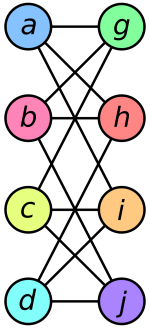
GRAPH INSIGHTS 101

- **Graph Analytics**
  - ***An Action Performed:*** The act of analysing connected data - using any appropriate graph-based approach or tools (visualisations, queries, statistics, algorithms)

- **Graph Algorithms**
  - ***Programmable process or set of rules:*** Leverages the mathematical properties of graphs to explore, classify and interpret connected data. A subset of tooling used to do graph analytics.

GRAPH INSIGHTS 101

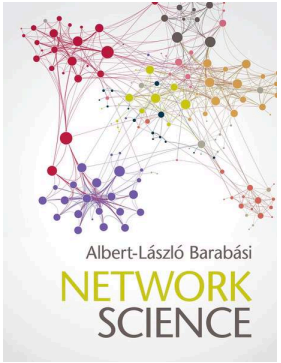
GRAPH THEORY



Roots date back to 1786, includes study of:

- Abstract theoretical graph forms (e.g. random graphs, trees, directed graphs)
- Graphs of any size

NETWORK SCIENCE



New academic field, circa 21st century includes study of:

- Real-world representations in order to understand the universal properties of networks (Biological, social, transport)
- Large, complex networks

GRAPH INSIGHTS 101

"Based on the mathematics of graph theory, graph algorithms use the relationships between nodes to infer the organization and dynamics of complex systems. Network scientists use these algorithms to uncover hidden information, test hypotheses, and make predictions about behavior".

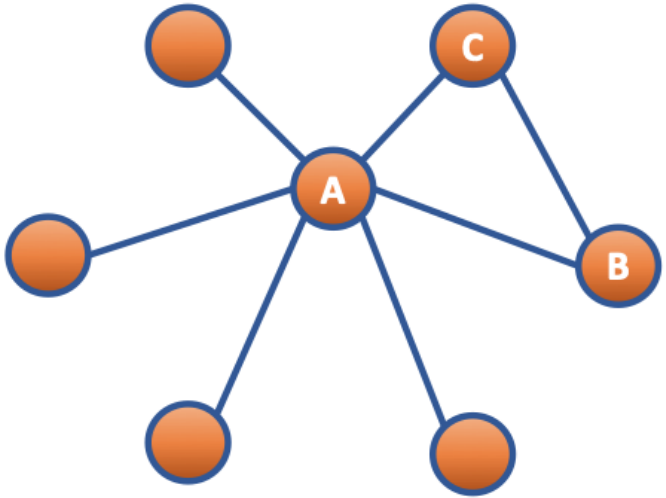
- Graph Algorithms by M Needham, A Hodler

Show me some of this graph theory / network science stuff ...

HIGH LEVEL ALGORITHM TYPES

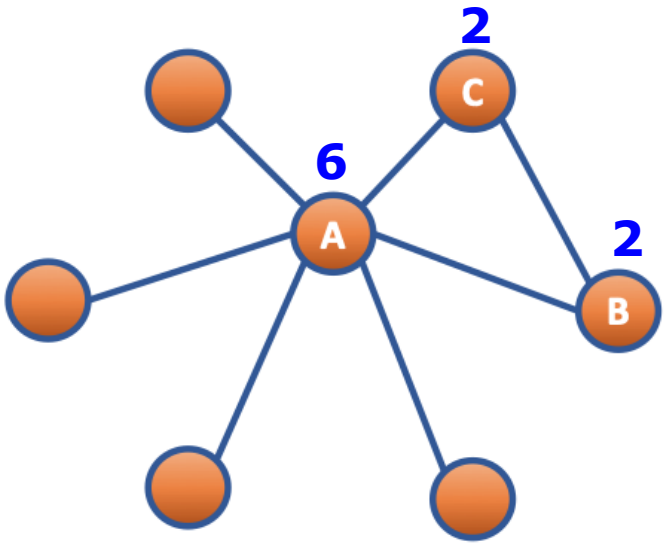
HIGH LEVEL ALGORITHM TYPES

1 DEGREE



How connected is a specific node?

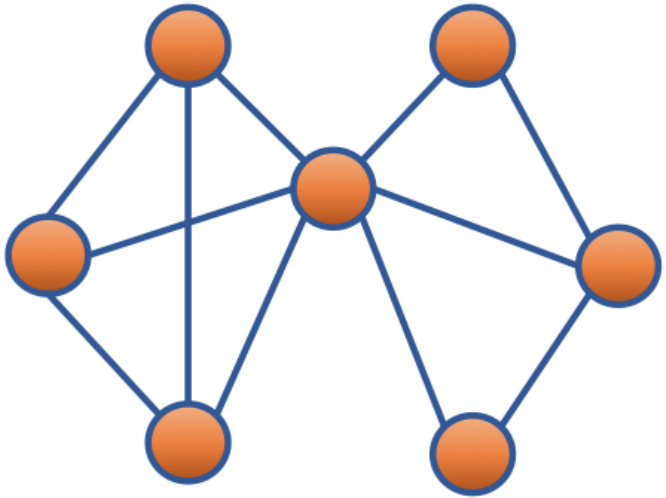
1 DEGREE



How connected is a specific node?

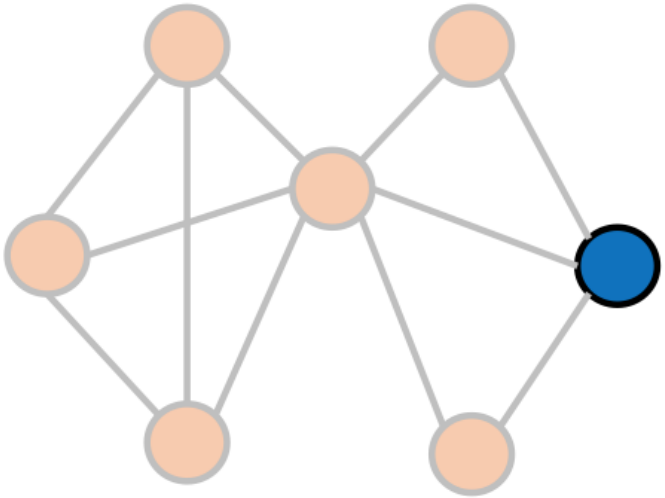
A is more highly connected than **B** and **C**

2 CLUSTER COEFFICIENT

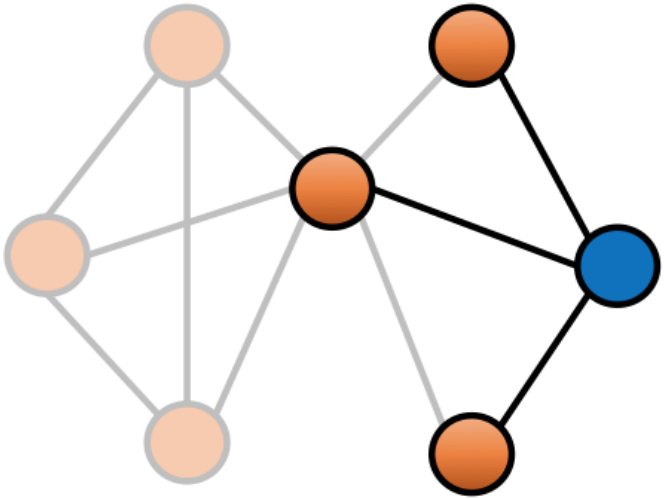


How tightly is a group clustered, compared to how tightly it could be clustered?

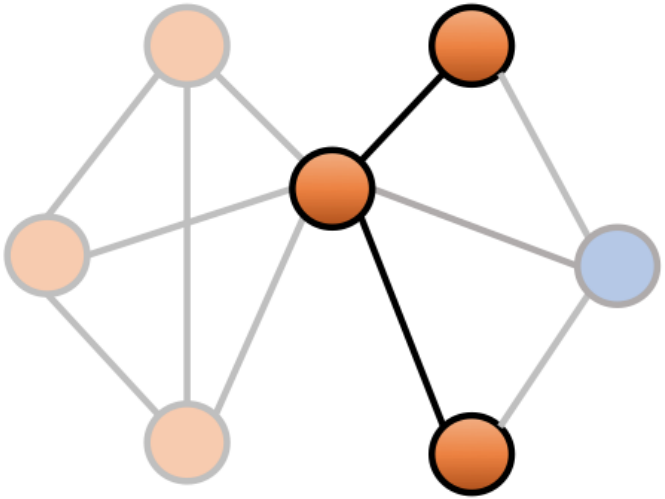
2 CLUSTER COEFFICIENT



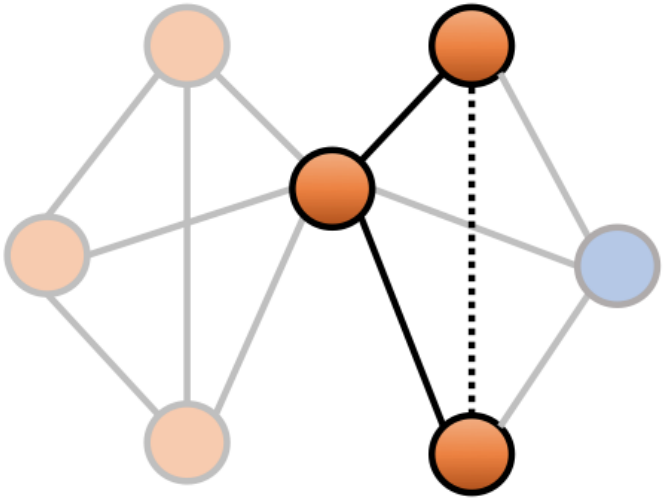
2 CLUSTER COEFFICIENT



2 CLUSTER COEFFICIENT

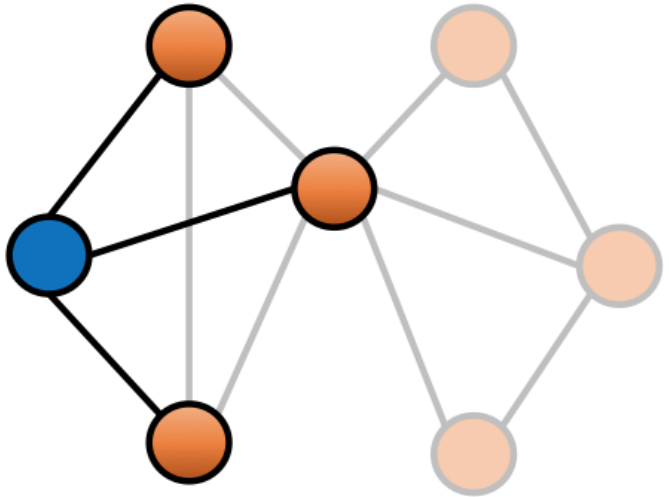


2 CLUSTER COEFFICIENT



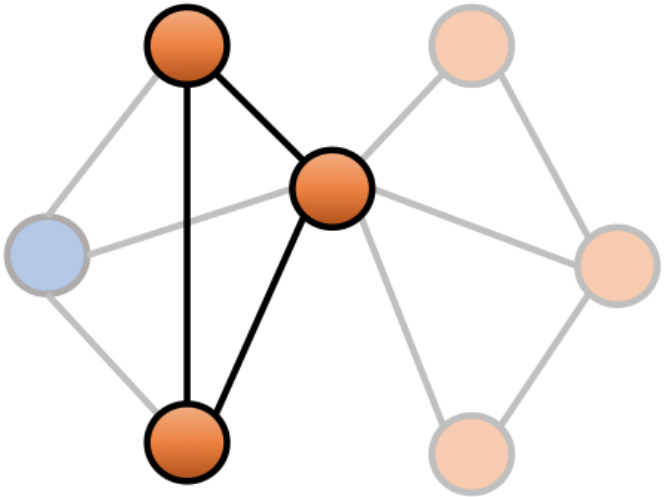
0.66

2 CLUSTER COEFFICIENT



0.66

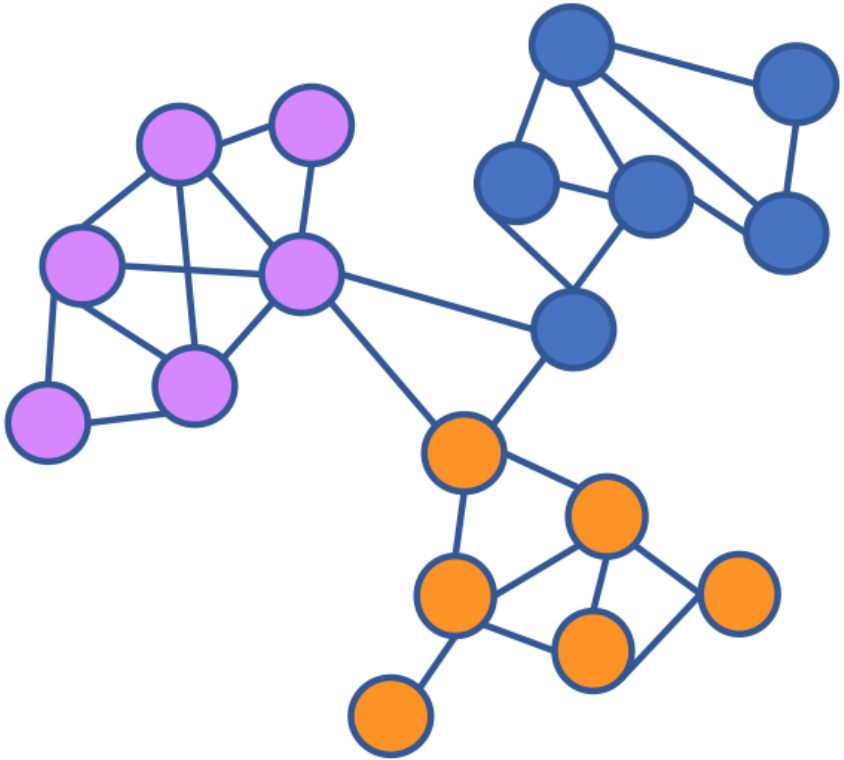
2 CLUSTER COEFFICIENT



1.0

0.66

3 COMMUNITY DETECTION



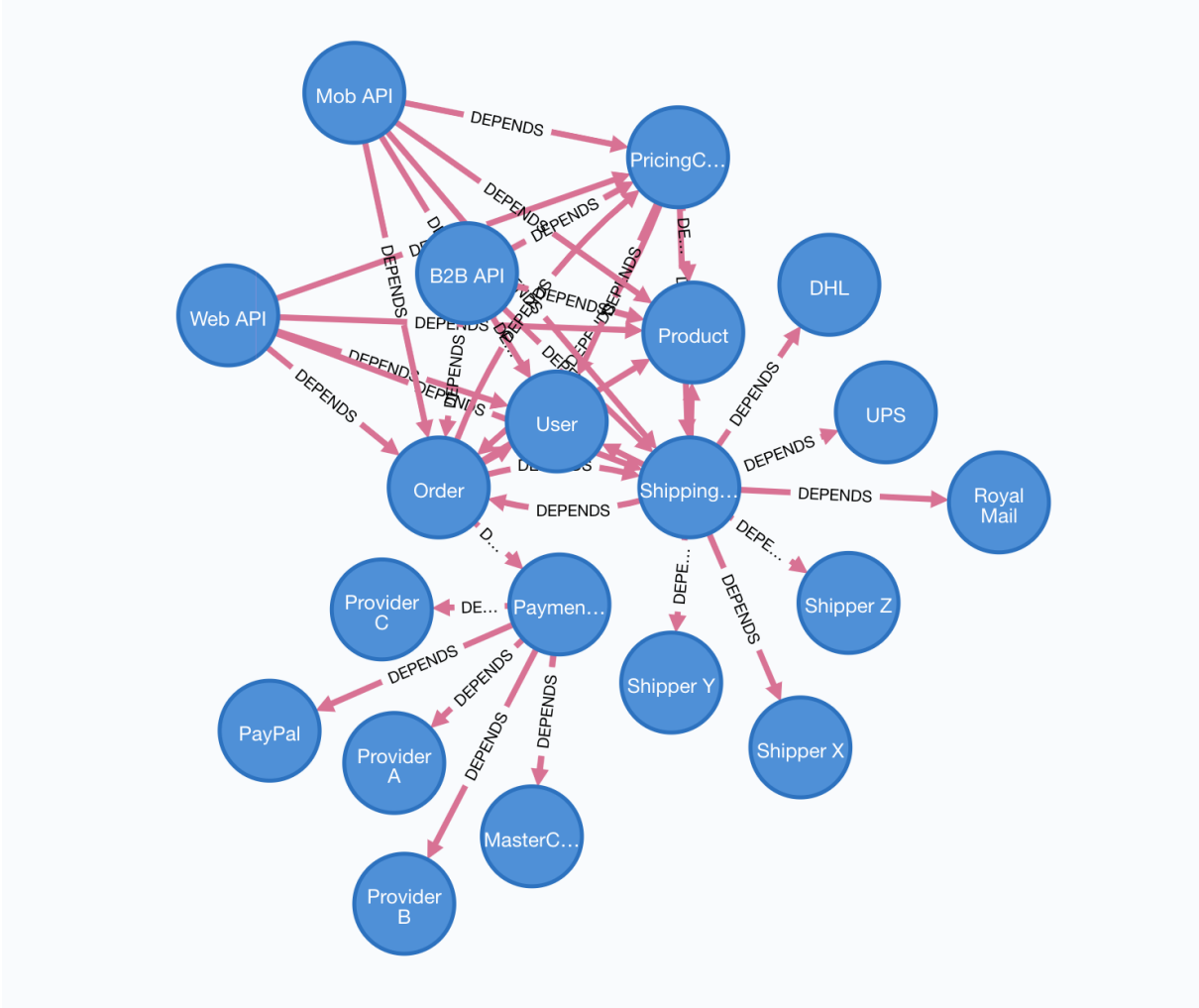
Used to find related communities, uncover groupings, and quantify the quality of groupings

DIVE IN!
EXPLORING MICROSERVICES (AS A NETWORK)

@techiewatt

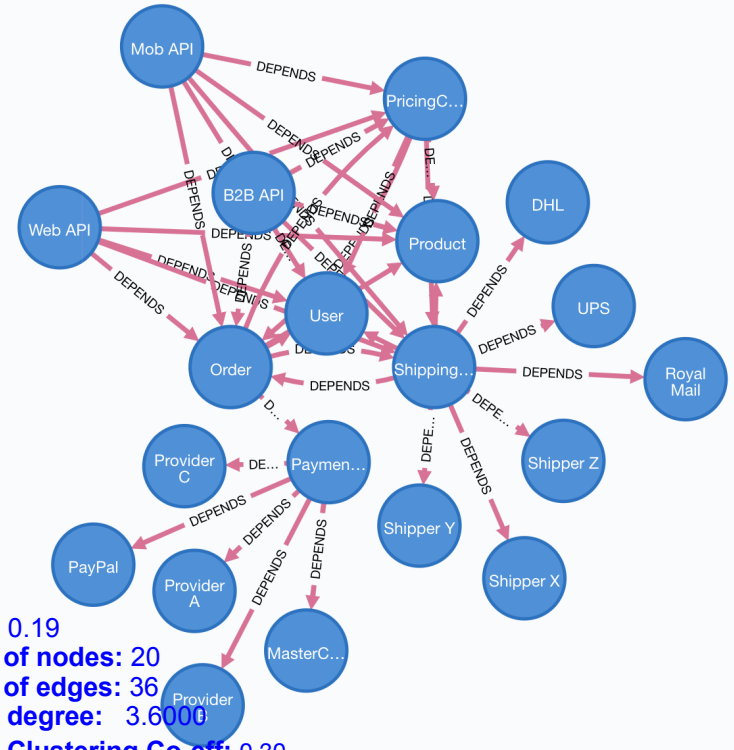
#1
A “Microservice” Architecture
(v1.0)

V1.0


Mob API
PricingC…
B2B API
Web API
Product
DHL
User
UPS
Order
Shipping…
Royal Mail
Provider C
Paymen…
Shipper Z
Shipper Y
PayPal
Provider A
Shipper X
MasterC…
Provider B
DEPENDS

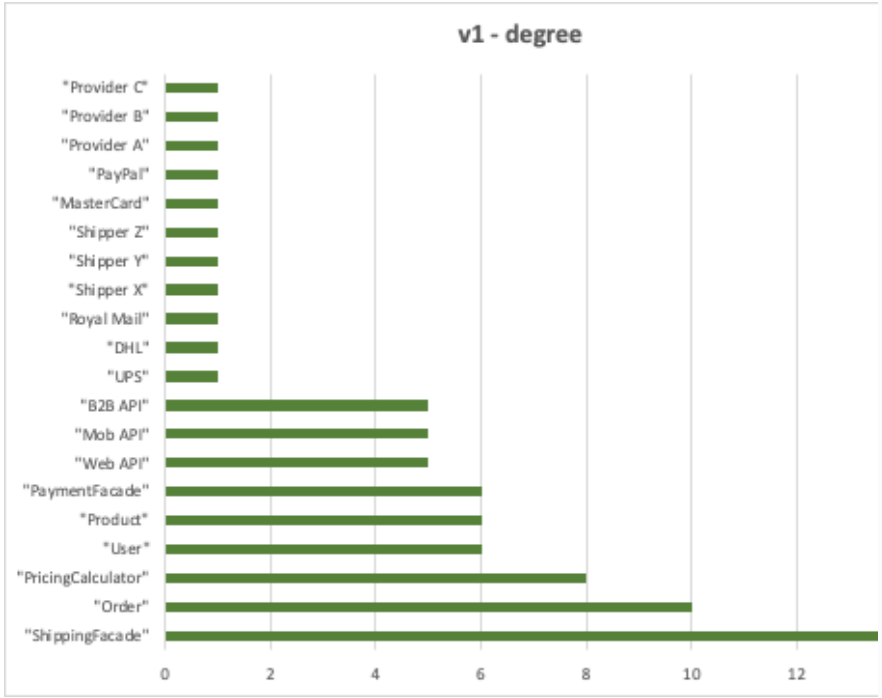
V1.0 - NETWORK STATS

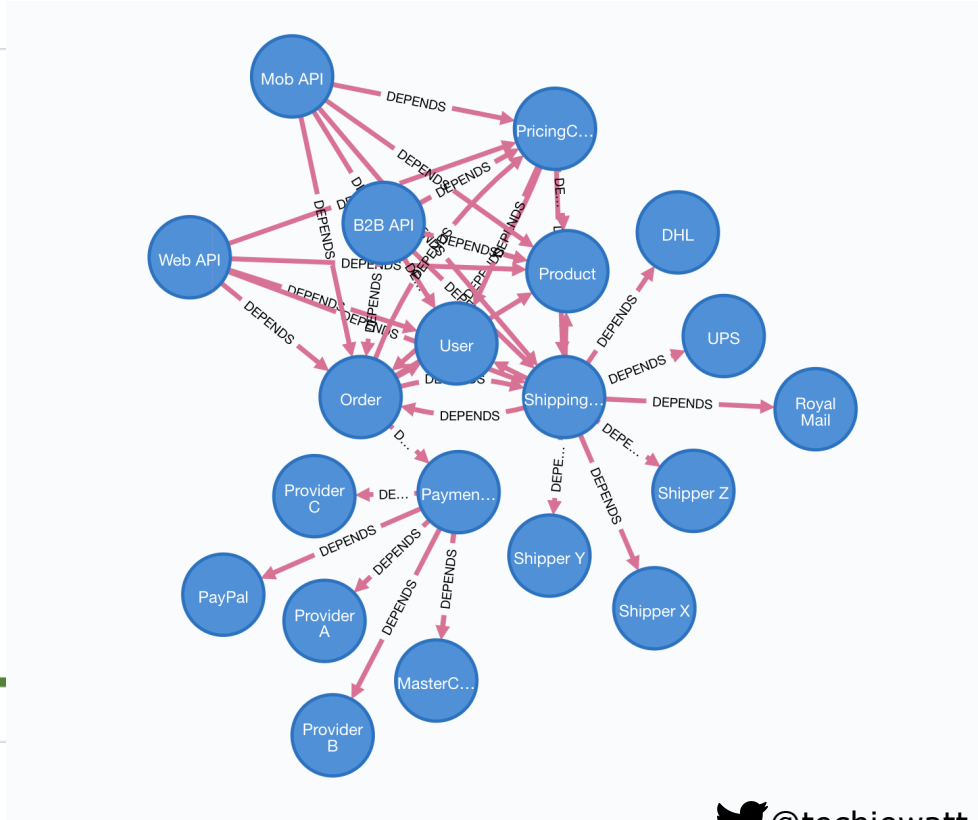
name	degree	degree_in	degree_out	triangles	cluster_coeff
ShippingFacade	14.0	5.0	9.0	17	0.21794871794871795
Order	10.0	5.0	5.0	17	0.6071428571428571
PricingCalculator	8.0	4.0	4.0	17	0.8095238095238095
User	6.0	6.0	0.0	12	0.8
Product	6.0	6.0	0.0	12	0.8
PaymentFacade	6.0	1.0	5.0	0	0.0
Web API	5.0	0.0	5.0	9	0.9
Mob API	5.0	0.0	5.0	9	0.9
B2B API	5.0	0.0	5.0	9	0.9
UPS	1.0	1.0	0.0	0	0.0
DHL	1.0	1.0	0.0	0	0.0
Royal Mail	1.0	1.0	0.0	0	0.0
Shipper X	1.0	1.0	0.0	0	0.0
Shipper Y	1.0	1.0	0.0	0	0.0
Shipper Z	1.0	1.0	0.0	0	0.0
MasterCard	1.0	1.0	0.0	0	0.0
PayPal	1.0	1.0	0.0	0	0.0
Provider A	1.0	1.0	0.0	0	0.0
Provider B	1.0	1.0	0.0	0	0.0
Provider C	1.0	1.0	0.0	0	0.0



@techiewatt

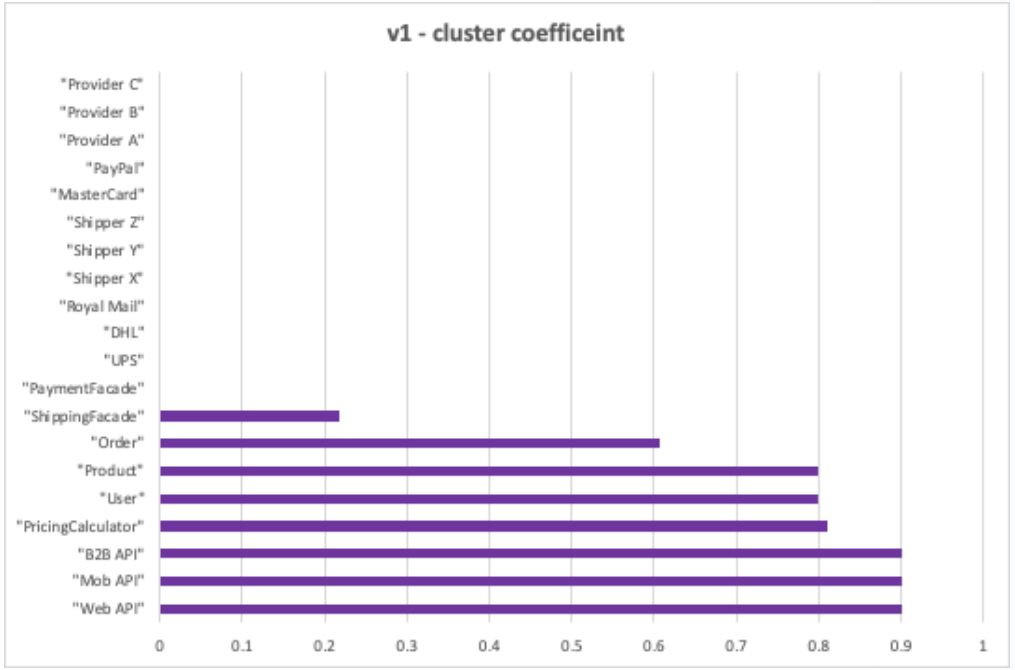
V1.0 - DEGREE

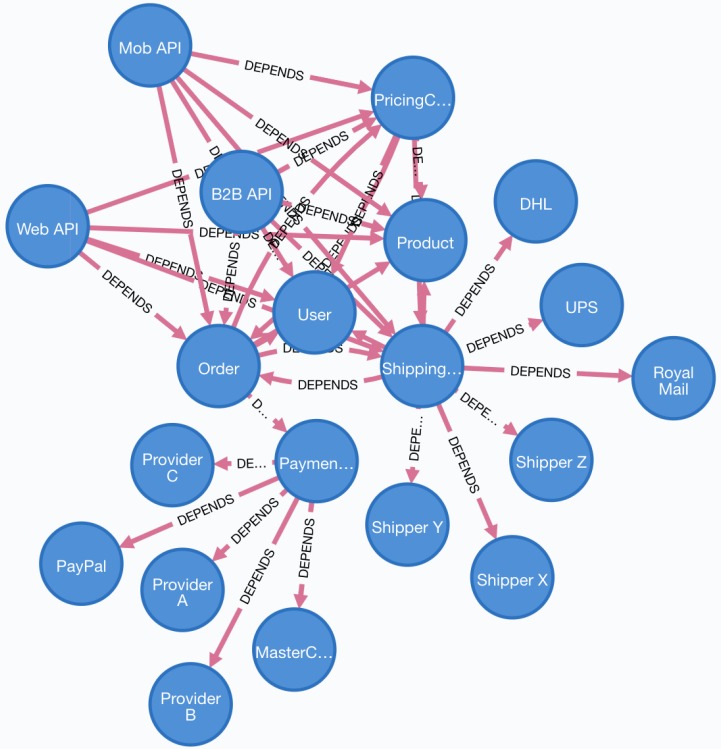




@techiewatt

V1.0 - CLUSTER COEFFICIENT



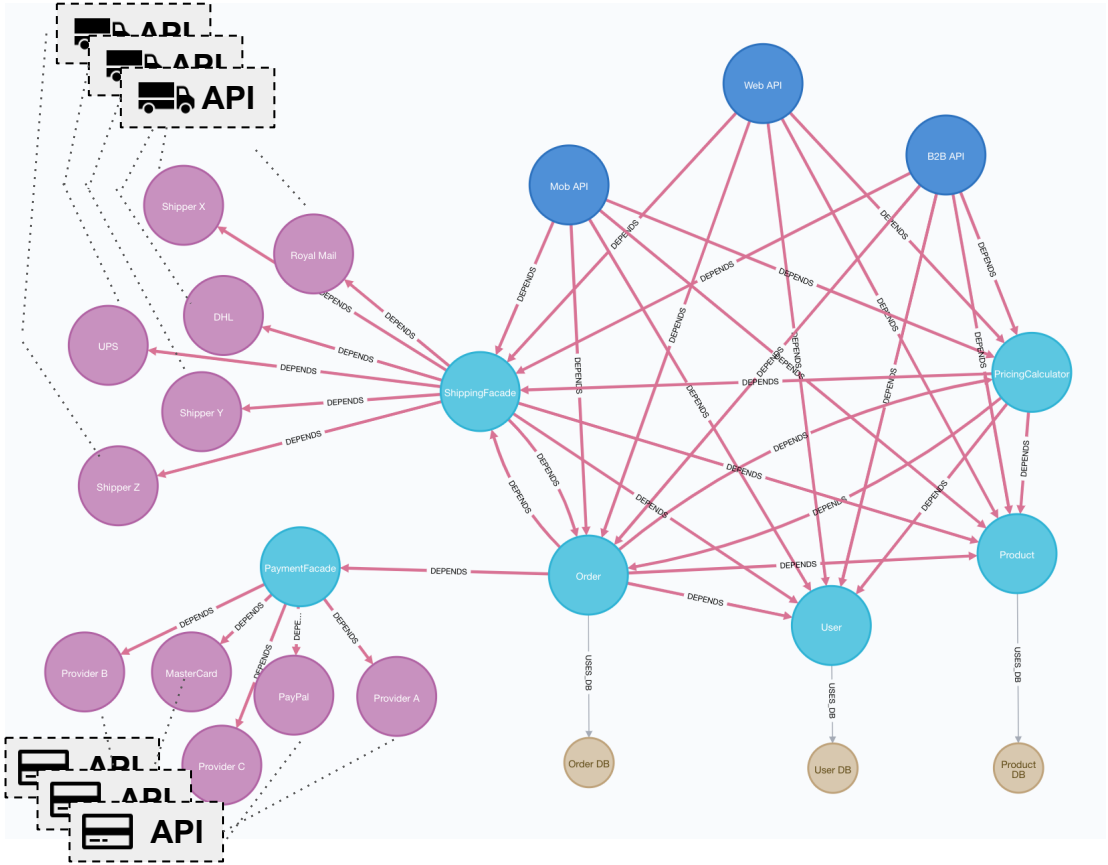


@techiewatt

We’ve been directed to look a bit closer at a few potential problem services …

Where do they fit in architecturally?

V1.0 - ARCHITECTURE DIAGRAM



Front End Service

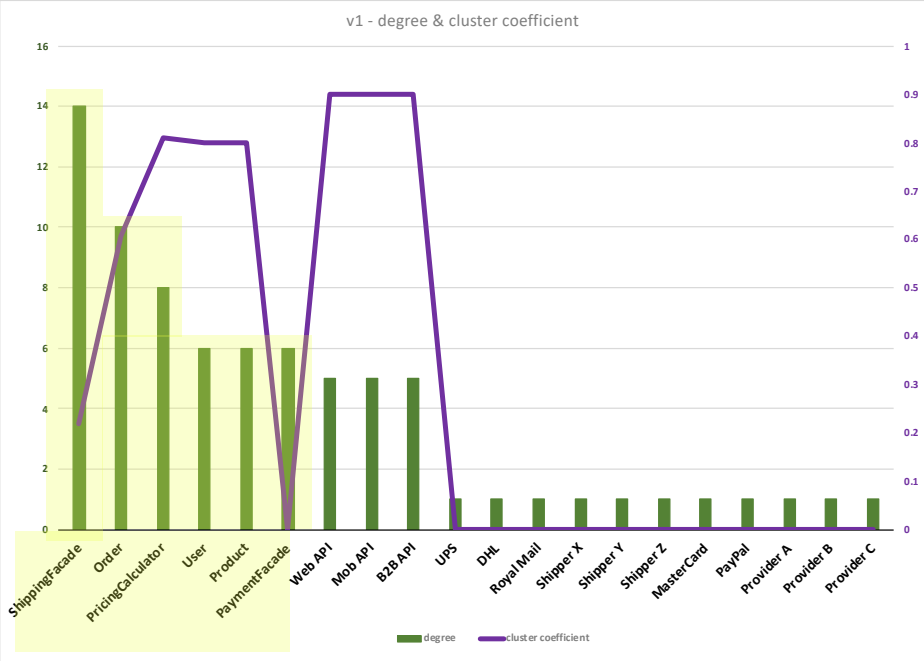
Back End Service

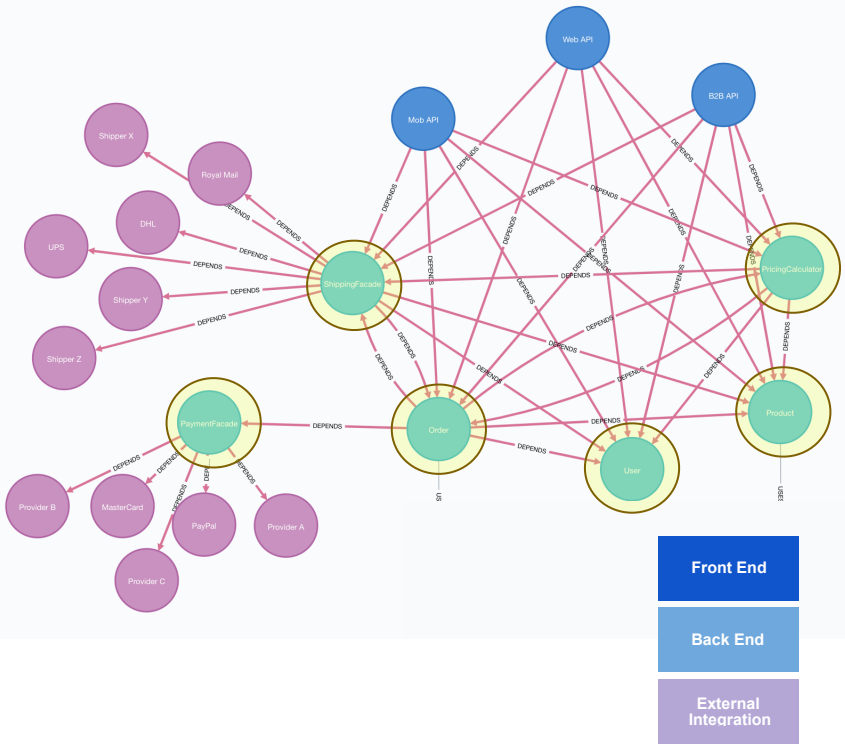
External Integration Adapter Service

Database

@techiewatt

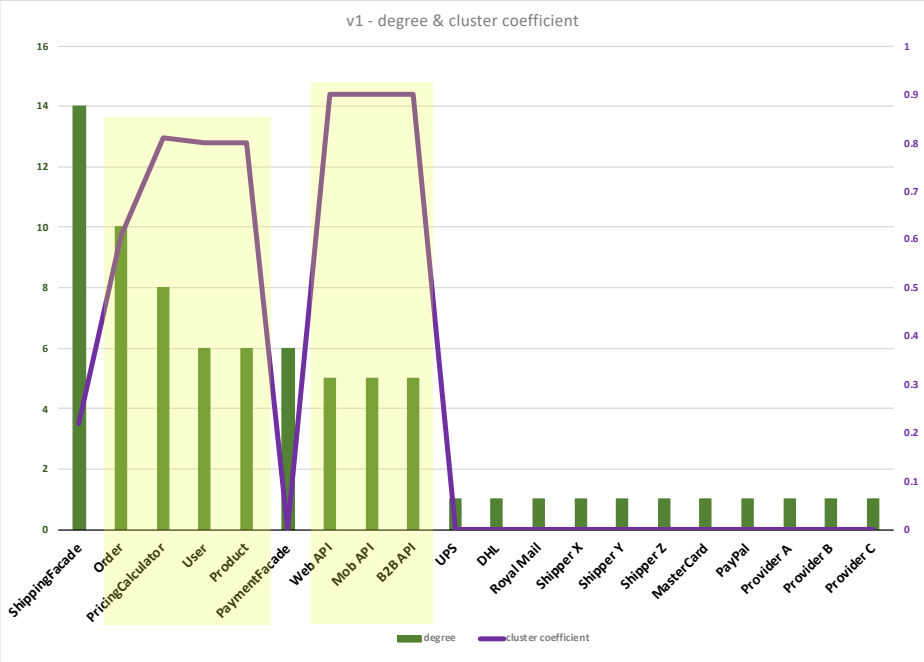
V1.0 ANALYSIS (DEGREE)

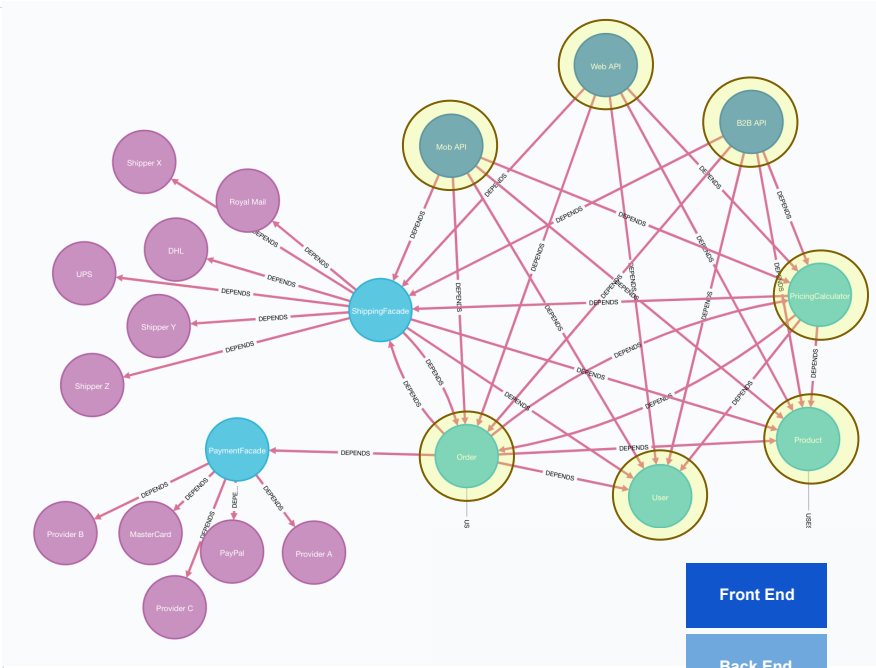




@techiewatt

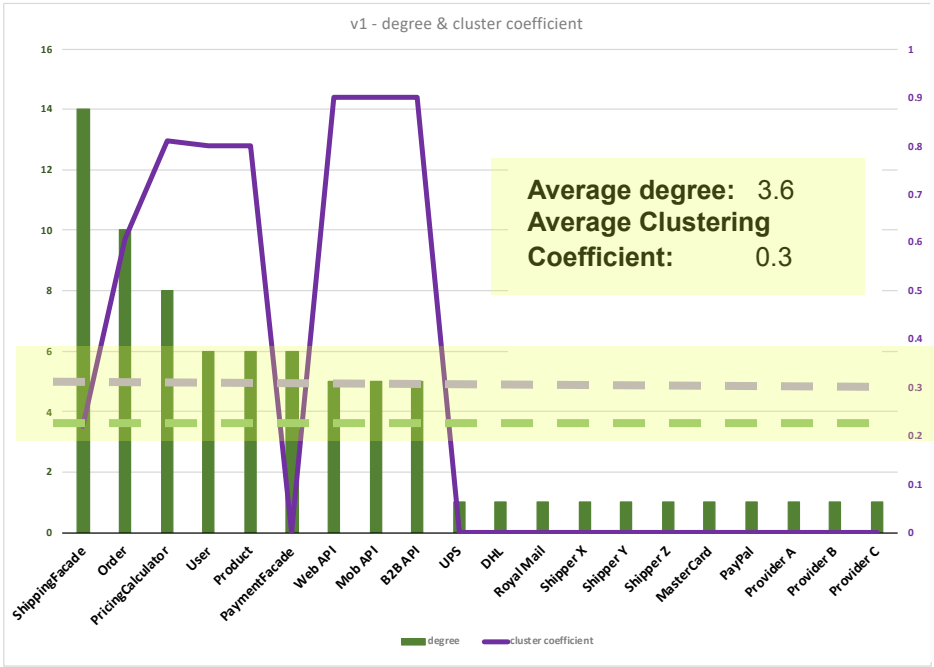
V1.0 ANALYSIS (CLUSTER COEFF)

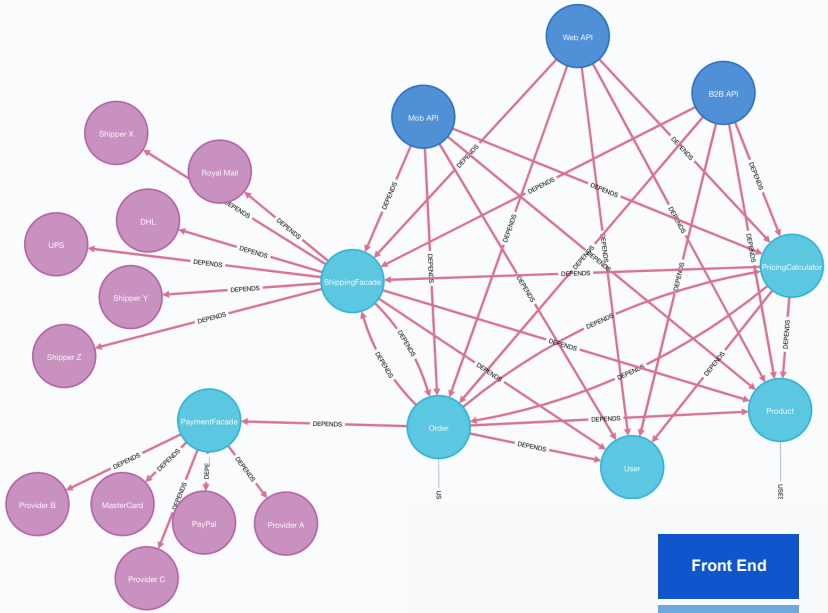




@techiewatt

V1.0 ANALYSIS (AVERAGES)

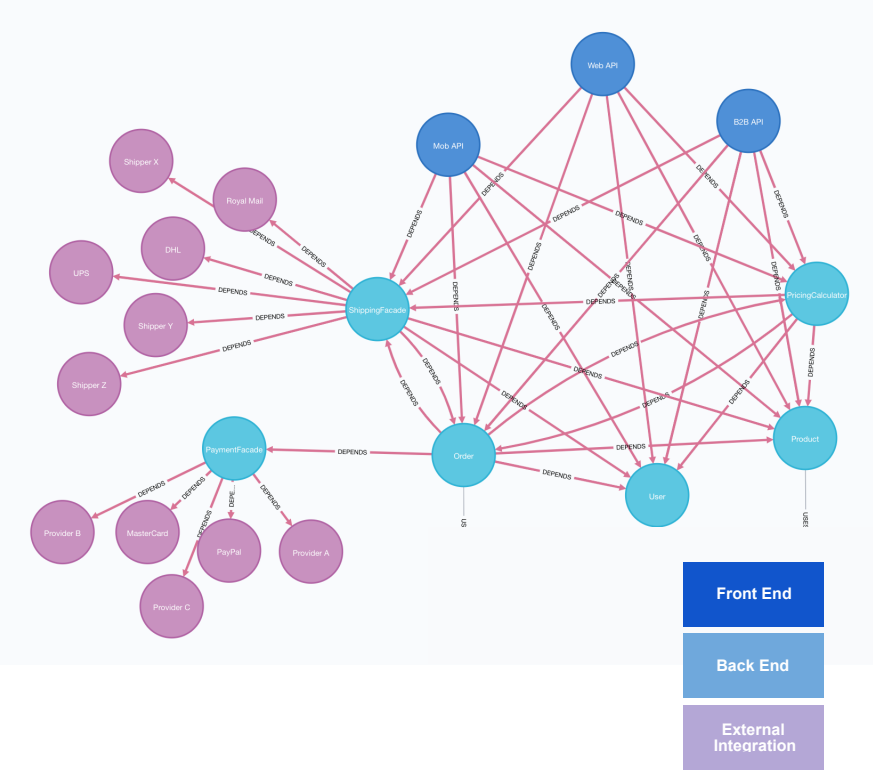




@techiewatt

V1.0 INVESTIGATION

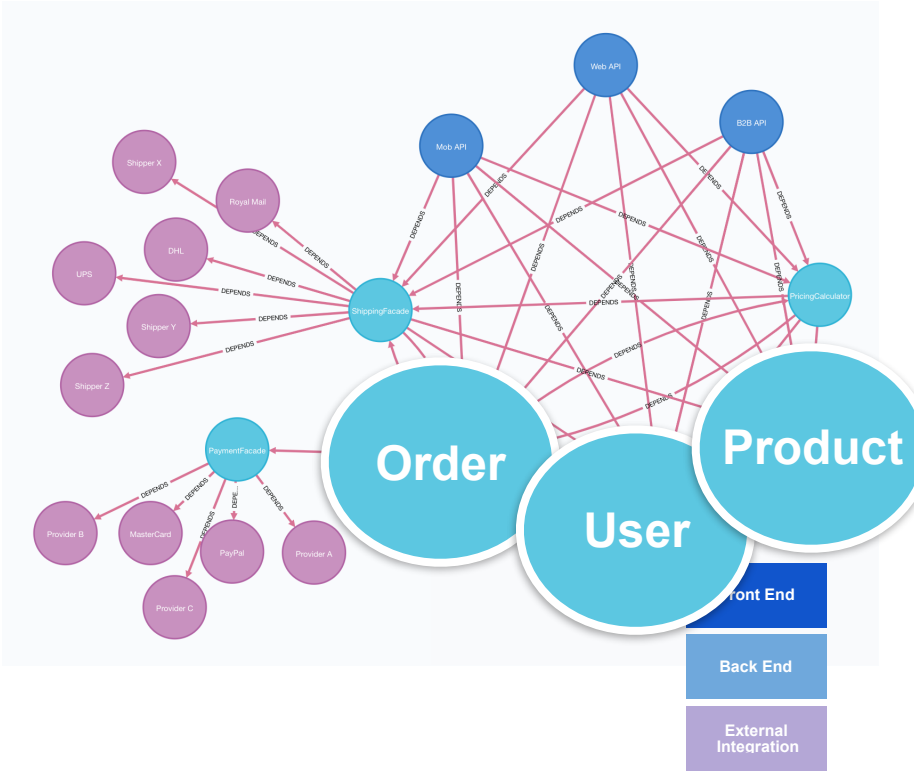
- Entity Services Anti-Pattern
- Distributed Monolith



@techiewatt

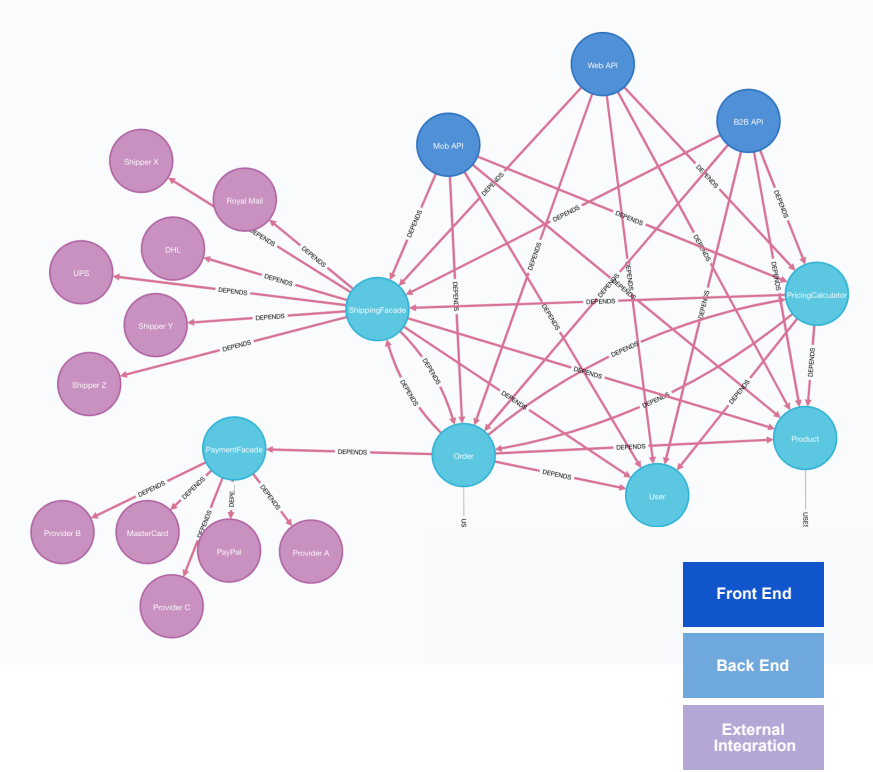
V1.0 INVESTIGATION

- Entity Services Anti-Pattern
- Distributed Monolith



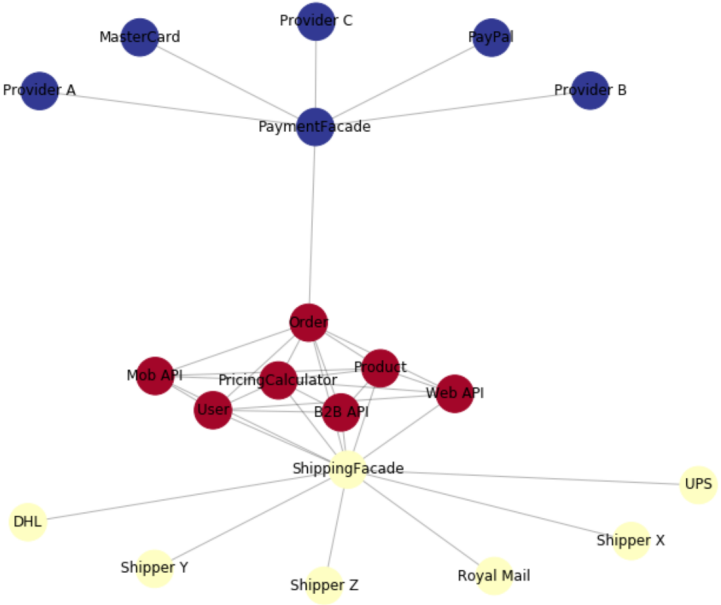
V1.0 INVESTIGATION

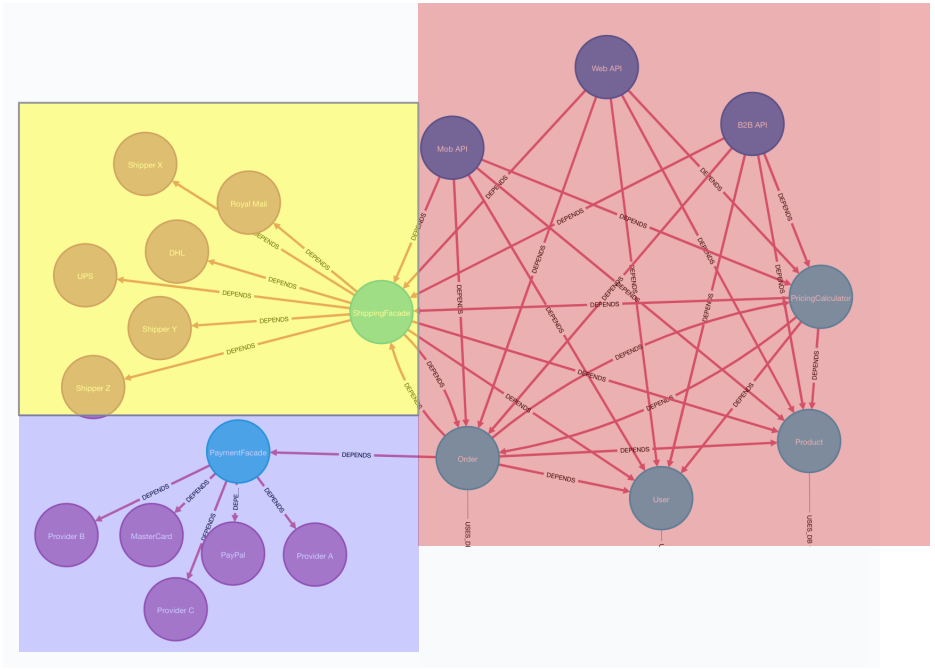
- Entity Services Anti-Pattern
- Distributed Monolith



@techiewatt

V1.0 - COMMUNITY DETECTION

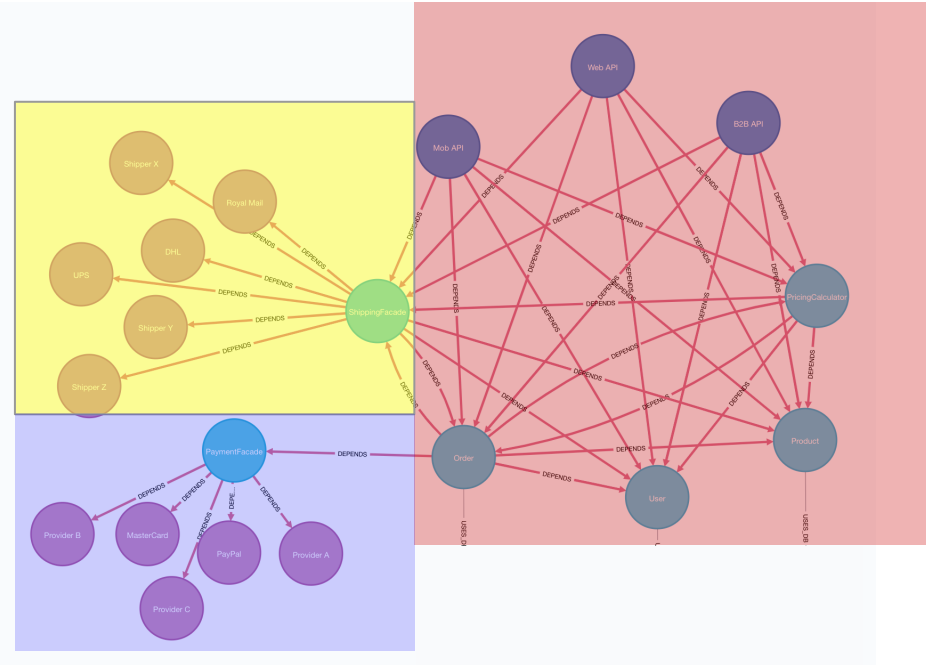




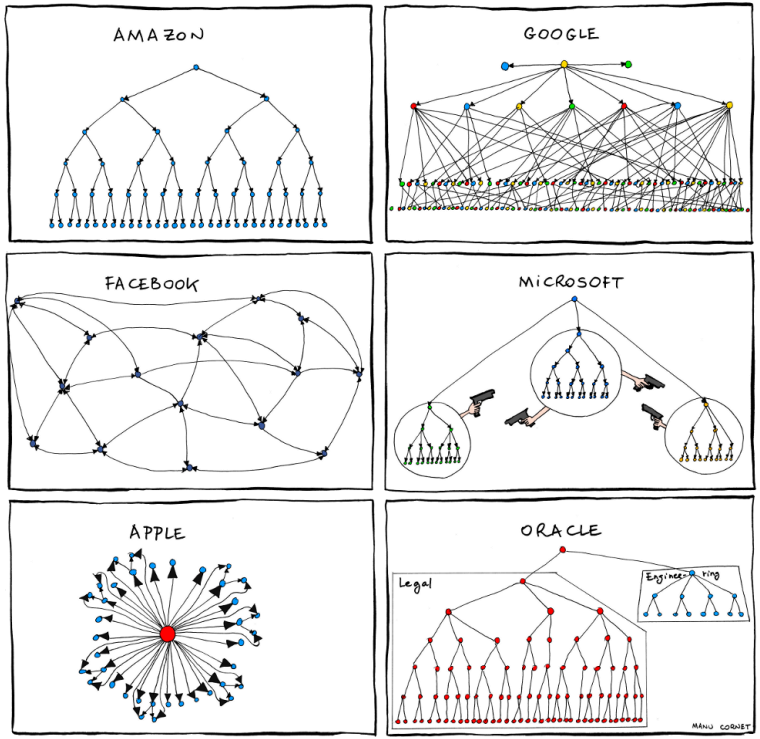
@techiewatt

V1.0 - OBSERVATIONS CONTINUED

- Help detect tightly coupled areas
- Not always DDD aligned



COMMUNITIES NOT ALWAYS DDD ALIGNED



Credit: http://bonkersworld.net/organizational-charts

Conway's Law ?

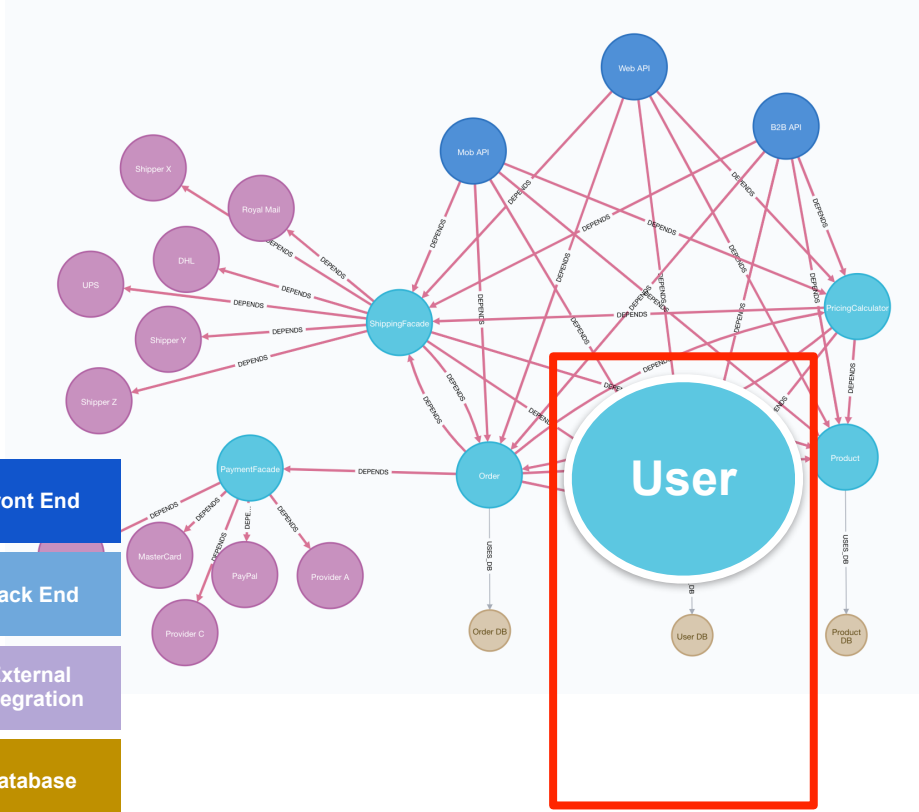
COMMUNITIES NOT ALWAYS DDD ALIGNED

Erich Eichinger Blog: “Heuristics for Identifying Service Boundaries”
https://opencredo.com/blogs/identify-service-boundary-heuristics/

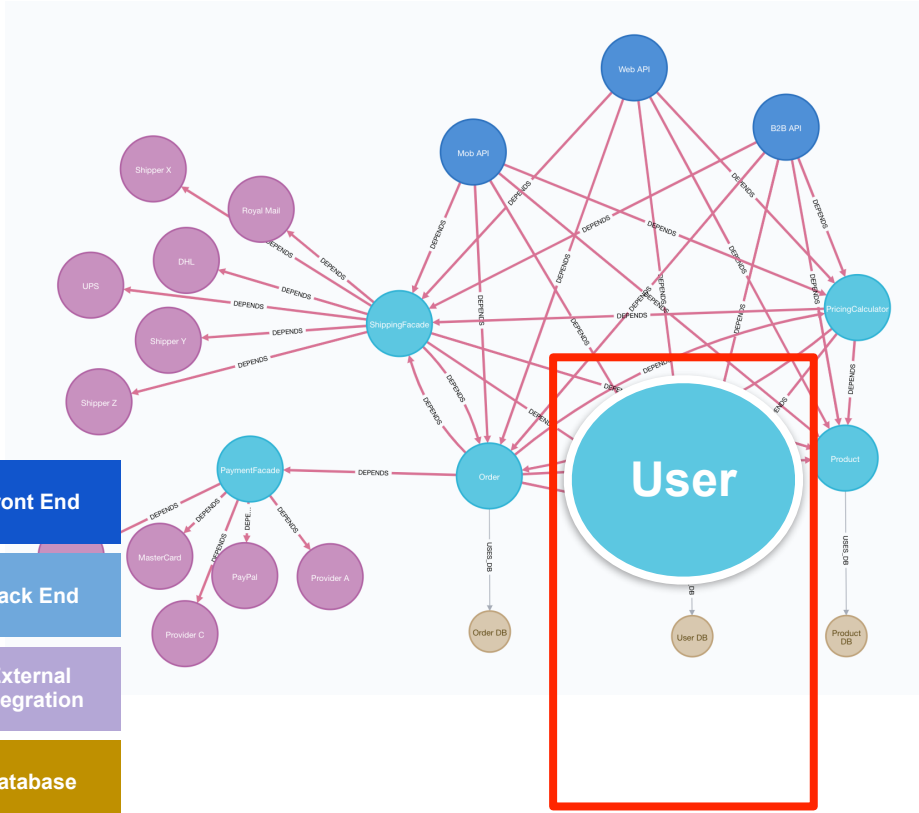
#2
The Revised Microservice Arch
User Domain Decoupling (v2.0)

@techiewatt

Recap … V1.0


Web API
Mob API
B2B API
Shipper X
Royal Mail
DHL
UPS
Shipper Y
Shipper Z
ShippingFacade
PricingCalculator
PaymentFacade
Order
User
Product
MasterCard
PayPal
Provider A
Provider C
Order DB
User DB
Product DB
DEPENDS
USER_DB
Front End
Back End
External Integration
Database

V1.0 —> V2.0



Front End

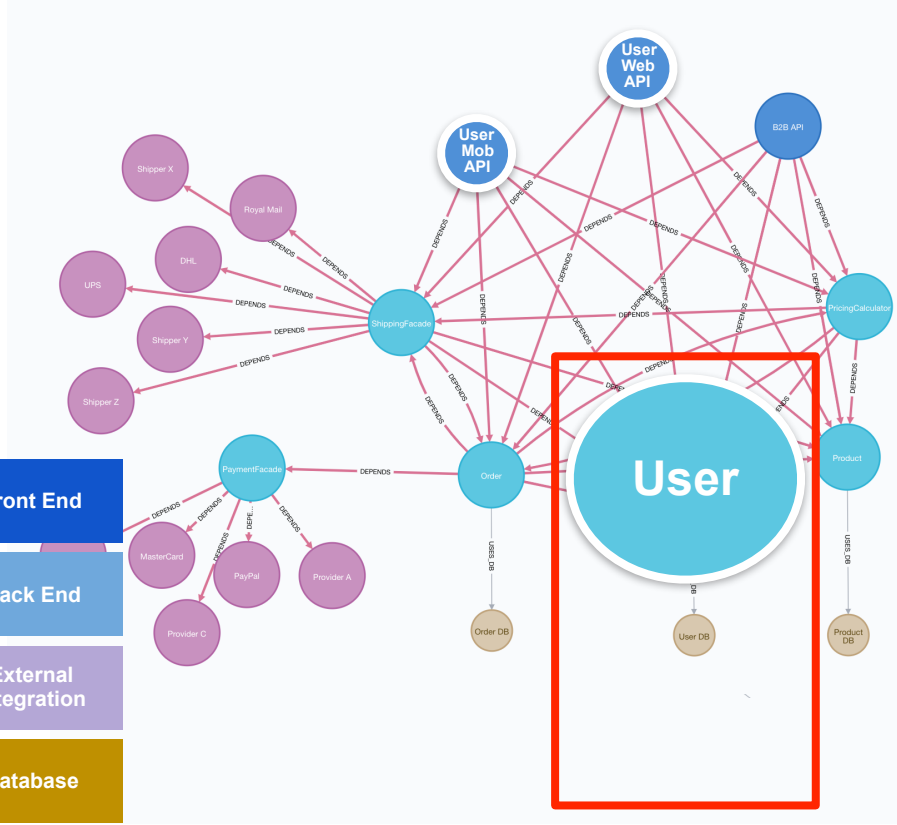
Back End

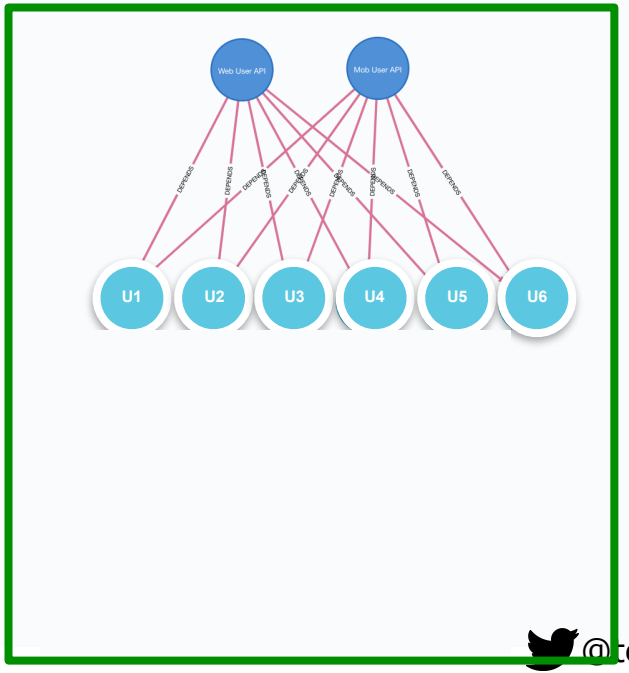
External Integration

Database

@techiewatt

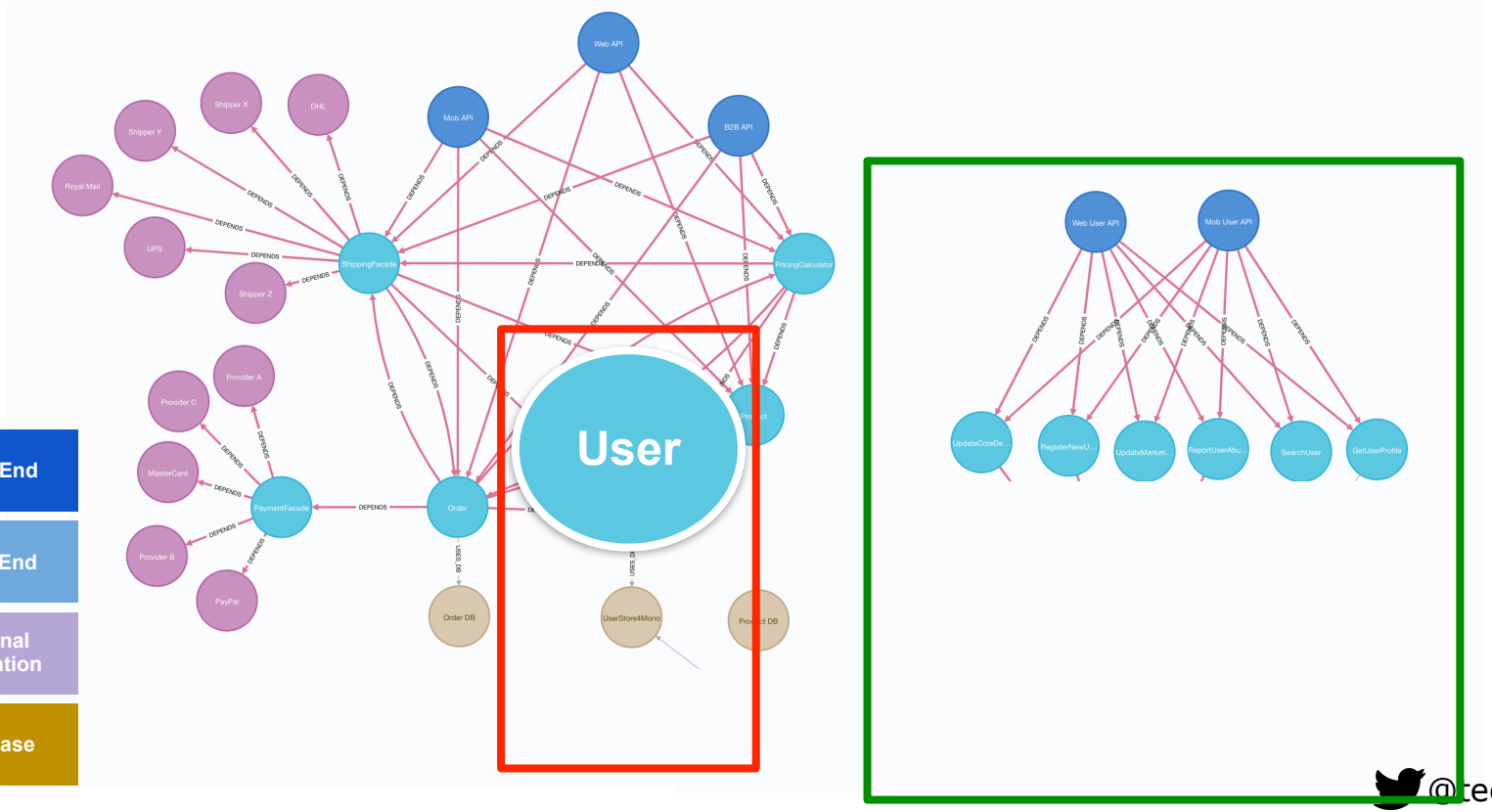
V1.0 —> V2.0





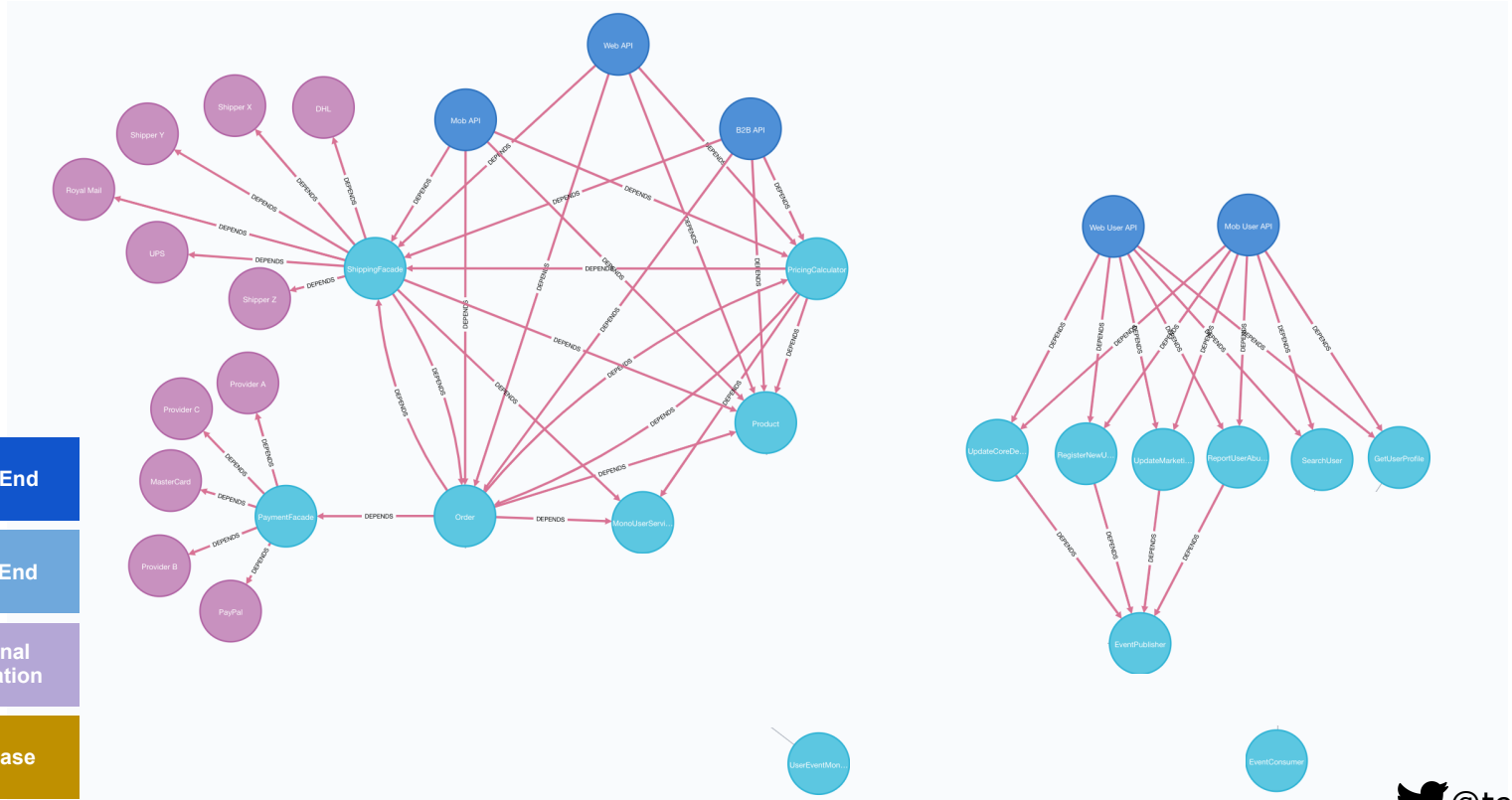
@techiewatt

V1.0 —> V2.0



@techiewatt

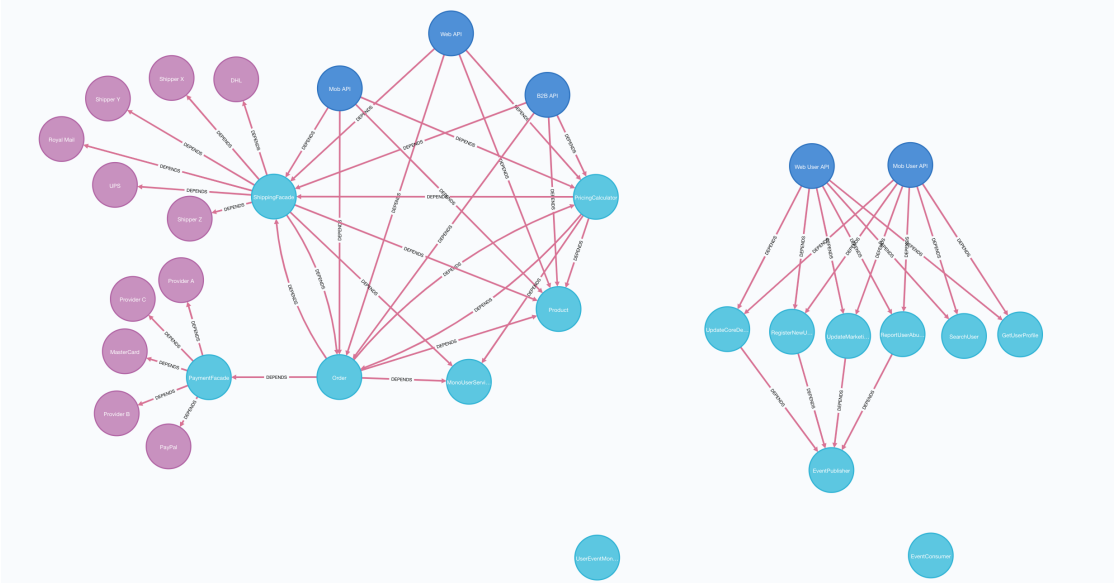
V2.0



@techiewatt

V2.0 - NETWORK STATS

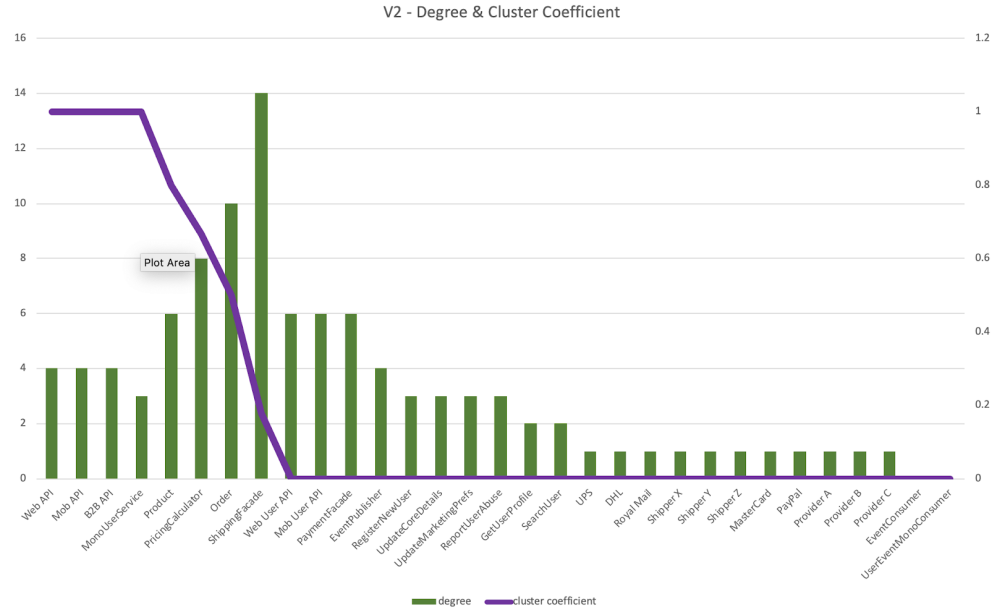
name	degree	degree_in	degree_out	triangles	cluster_coeff
ShippingFacade	14.0	5.0	9.0	14	0.1794871794871795
Order	10.0	5.0	5.0	14	0.5
PricingCalculator	8.0	4.0	4.0	14	0.6666666666666666
Web User API	6.0	0.0	6.0	0	0.0
Mob User API	6.0	0.0	6.0	0	0.0
Product	6.0	6.0	0.0	12	0.8
PaymentFacade	6.0	1.0	5.0	0	0.0
Web API	4.0	0.0	4.0	6	1.0
Mob API	4.0	0.0	4.0	6	1.0
B2B API	4.0	0.0	4.0	6	1.0
EventPublisher	4.0	4.0	0.0	0	0.0
RegisterNewUser	3.0	2.0	1.0	0	0.0
UpdateCoreDetails	3.0	2.0	1.0	0	0.0
UpdateMarketingPrefs	3.0	2.0	1.0	0	0.0
ReportUserAbuse	3.0	2.0	1.0	0	0.0
MonoUserService	3.0	3.0	0.0	3	1.0
GetUserProfile	2.0	2.0	0.0	0	0.0
SearchUser	2.0	2.0	0.0	0	0.0
UPS	1.0	1.0	0.0	0	0.0
DHL	1.0	1.0	0.0	0	0.0
Royal Mail	1.0	1.0	0.0	0	0.0
Shipper X	1.0	1.0	0.0	0	0.0
Shipper Y	1.0	1.0	0.0	0	0.0
Shipper Z	1.0	1.0	0.0	0	0.0
MasterCard	1.0	1.0	0.0	0	0.0
PayPal	1.0	1.0	0.0	0	0.0
Provider A	1.0	1.0	0.0	0	0.0
Provider B	1.0	1.0	0.0	0	0.0
Provider C	1.0	1.0	0.0	0	0.0
EventConsumer	0.0	0.0	0.0	0	0.0
UserEventMonoConsumer	0.0	0.0	0.0	0	0.0

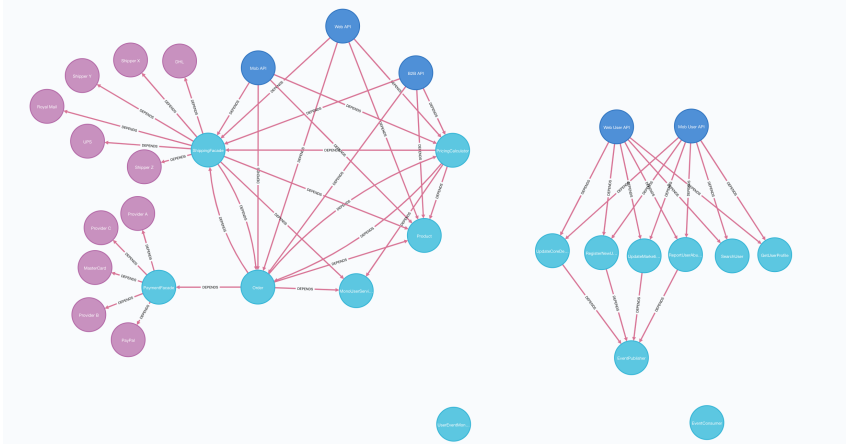


Density: 0.11
Number of nodes: 29
Number of edges: 46
Average degree: 3.1724
Average Clustering Co-eff: 0.20

@techiewatt

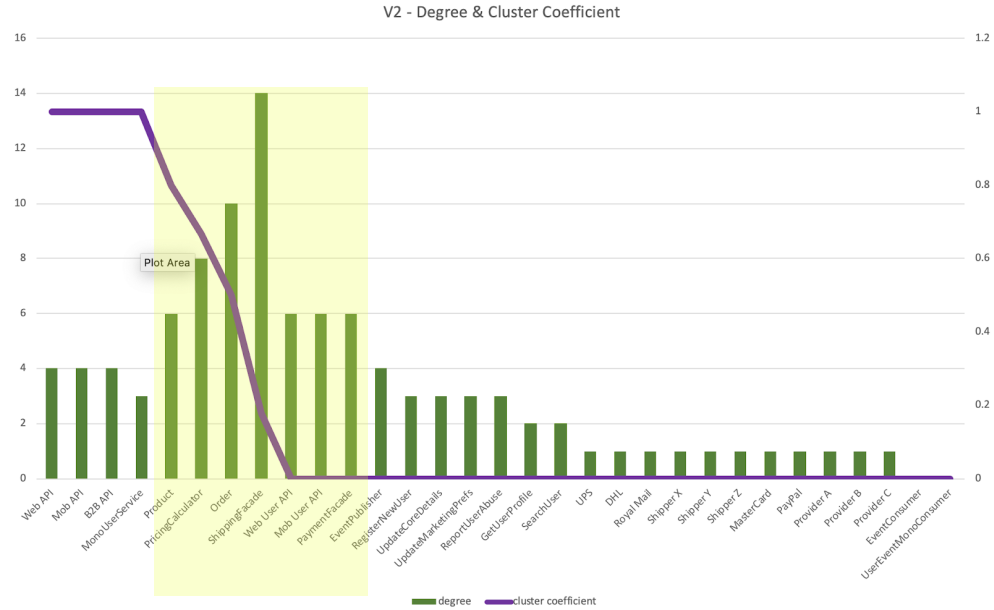
V2.0 - COMBINED STATS

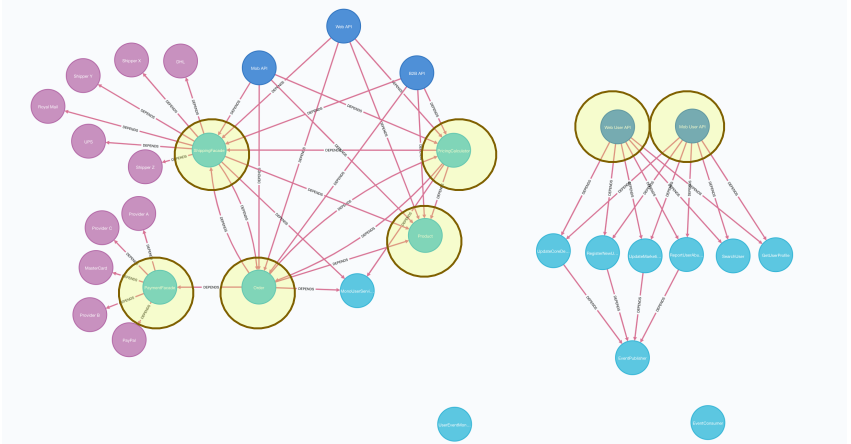




@techiewatt

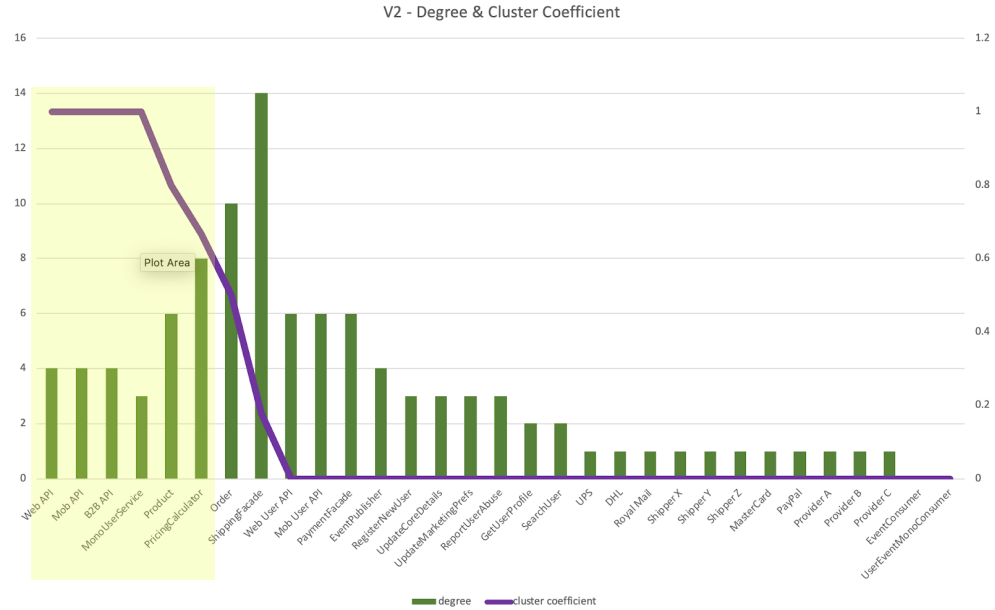
V2.0 - COMBINED STATS (DEGREE)

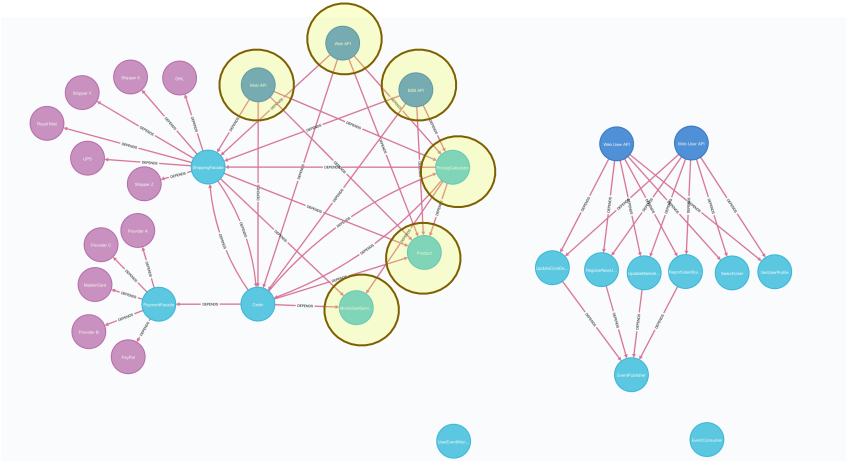




@techiewatt

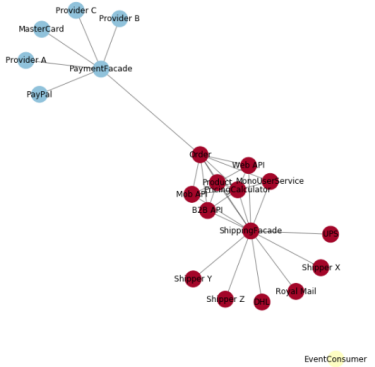
V2.0 - COMBINED STATS (CLUSTER COEFF)

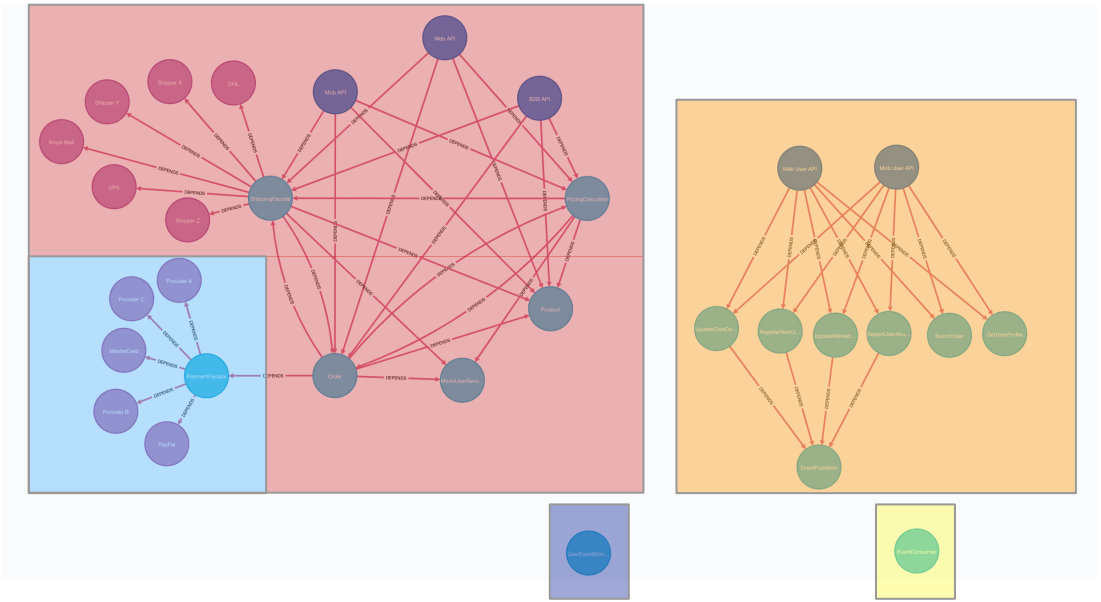




@techiewatt

V2.0 - COMMUNITY DETECTION

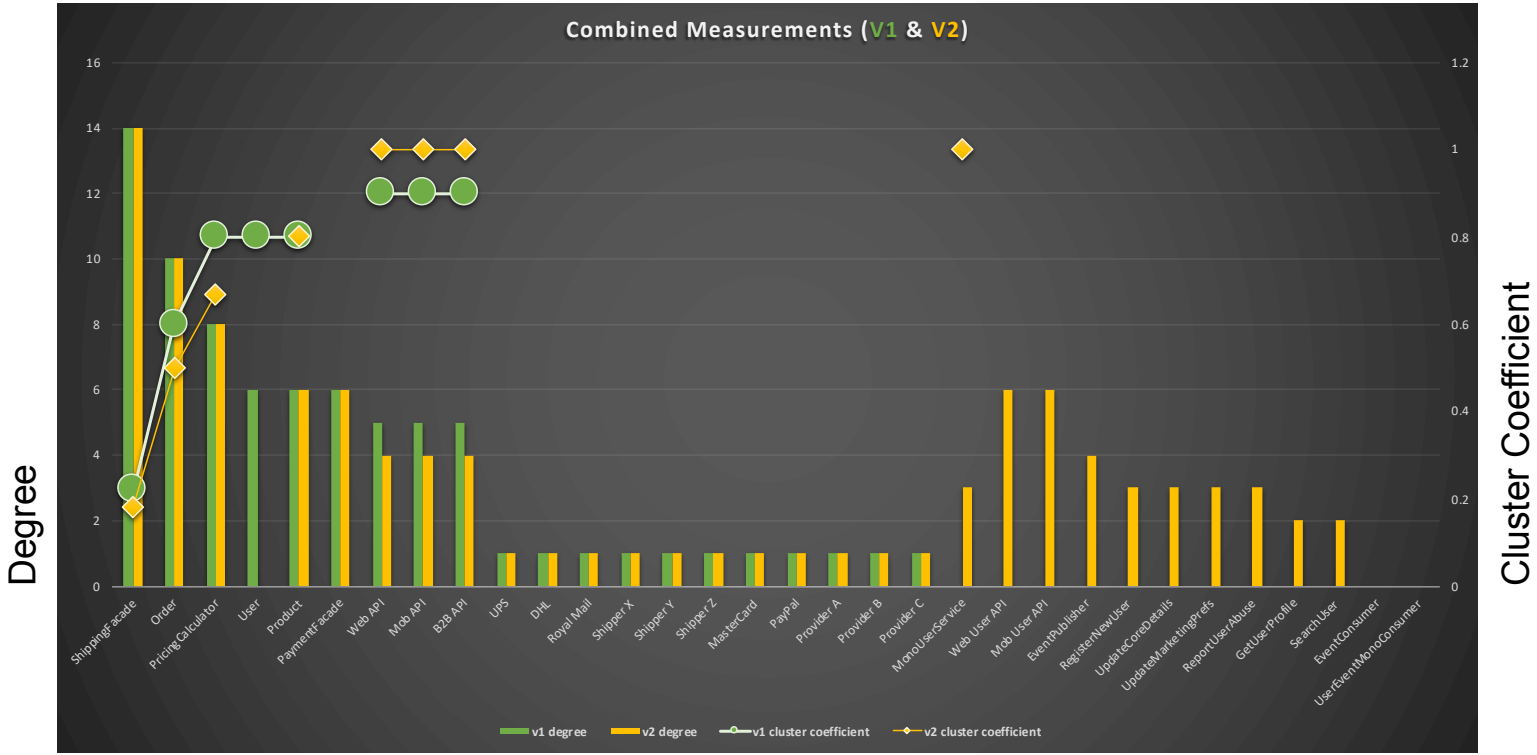




@techiewatt

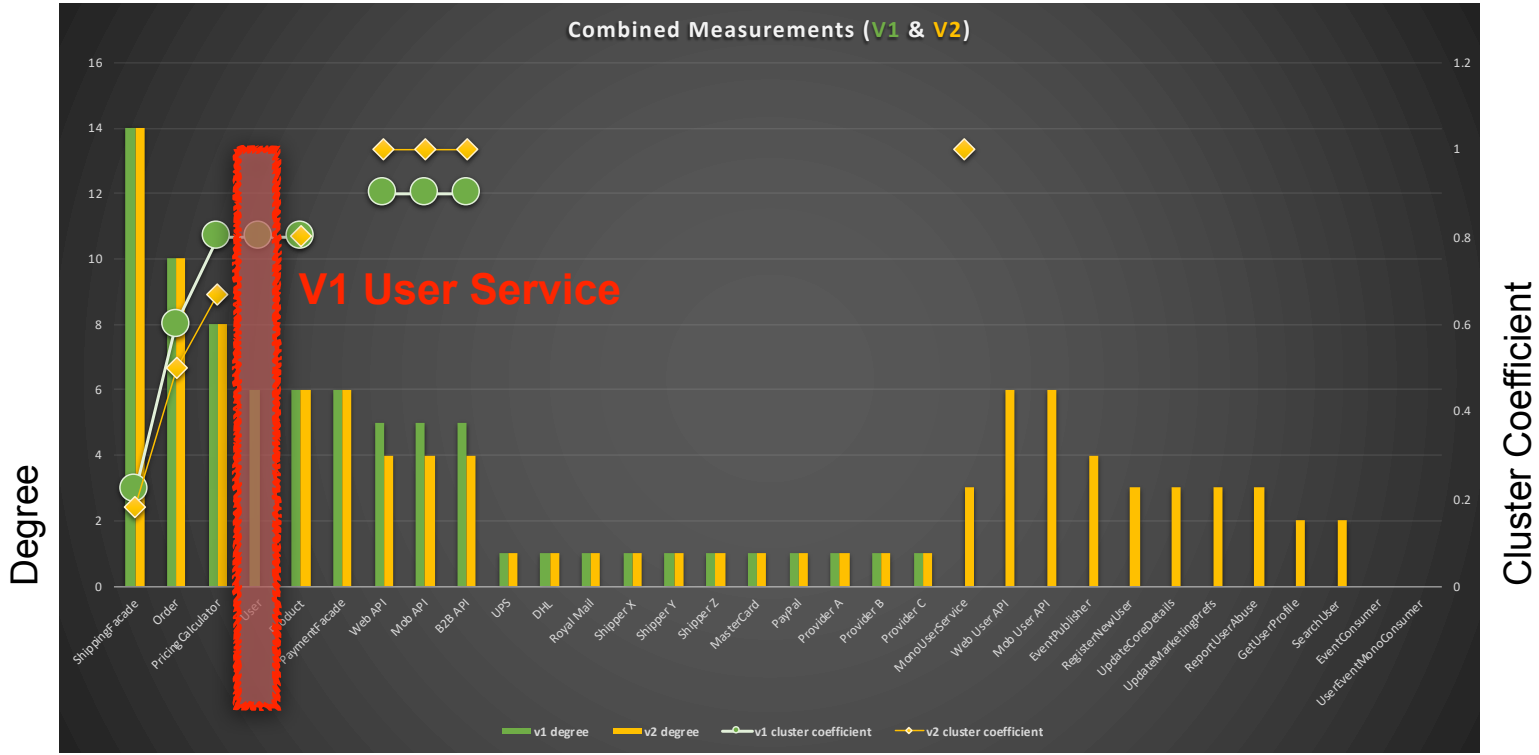
COMPARING V1 and V2

COMPARING



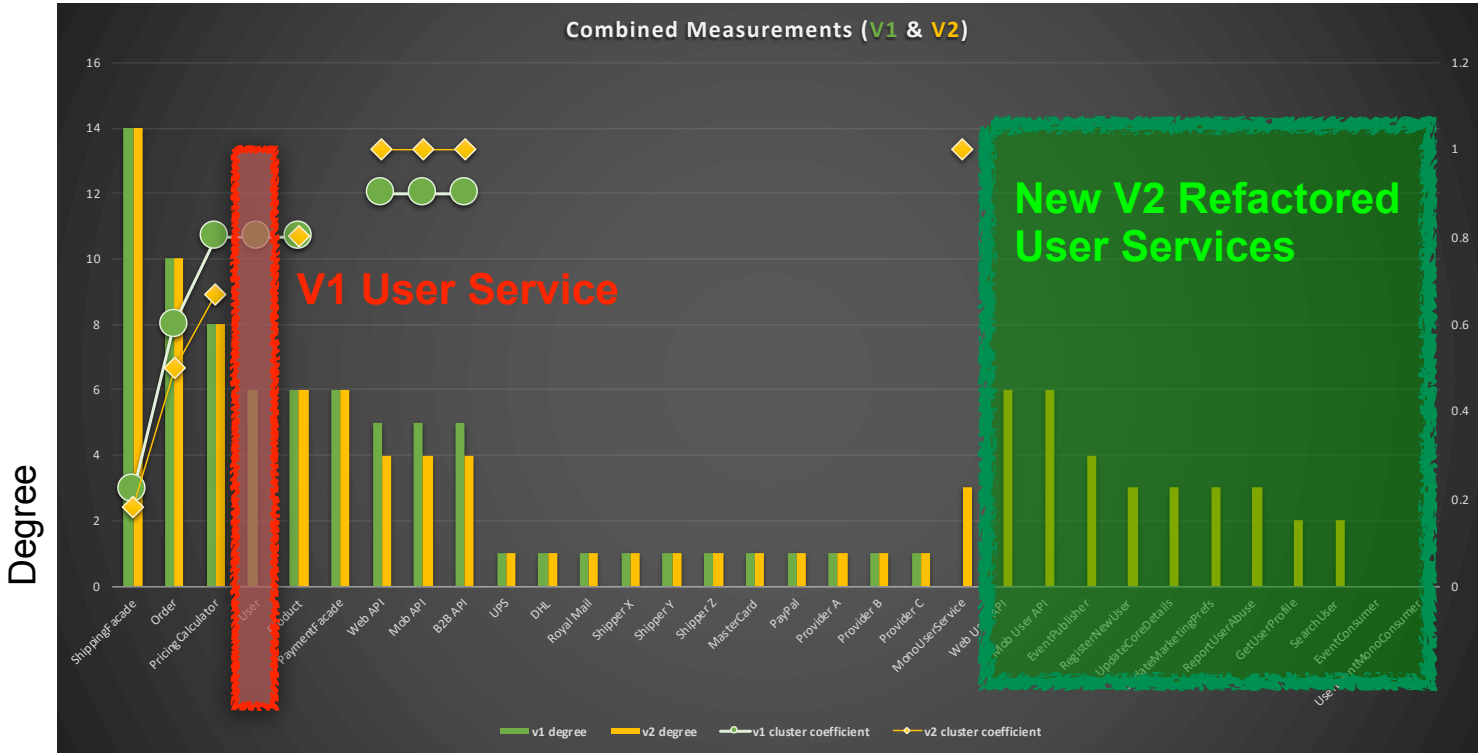
@techiewatt

COMPARING



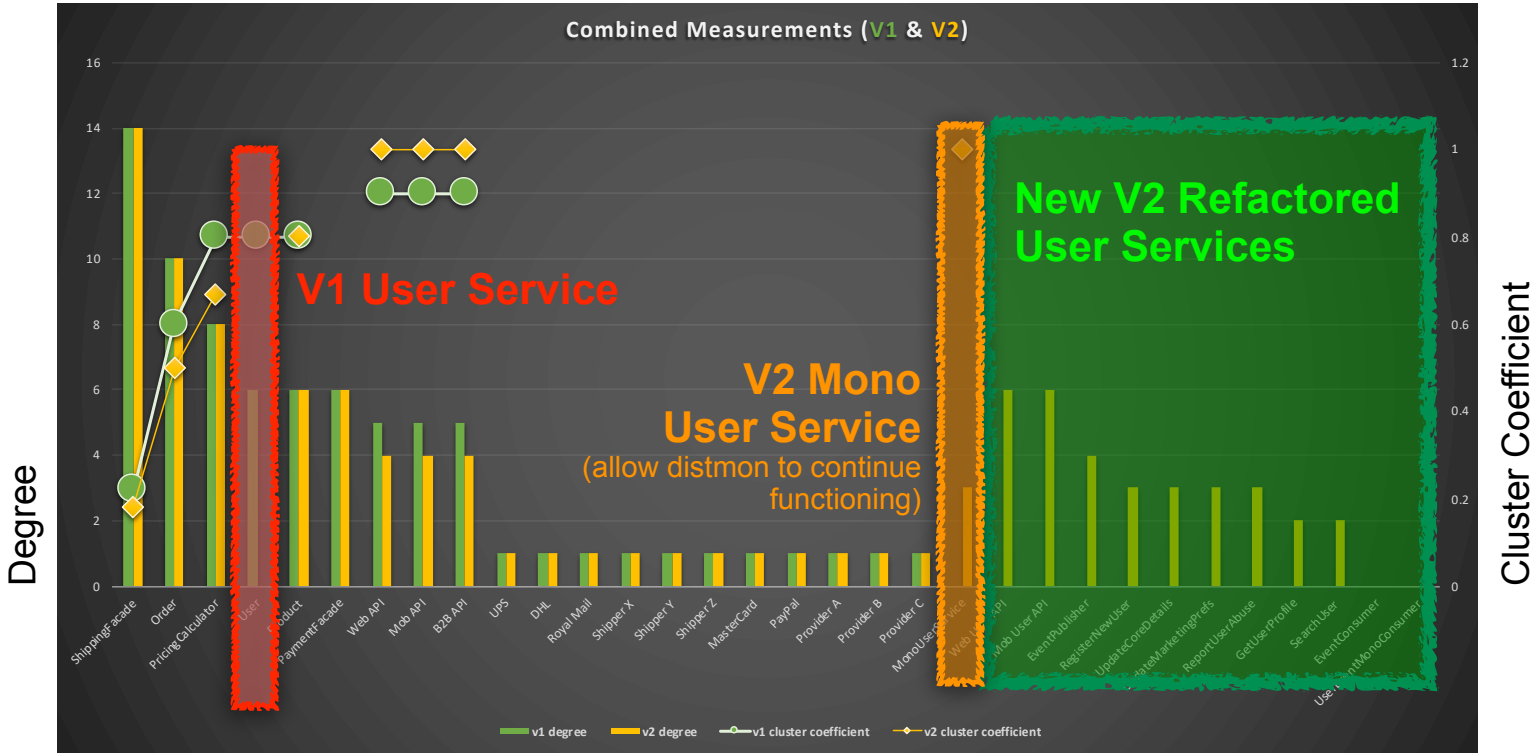
@techiewatt

COMPARING



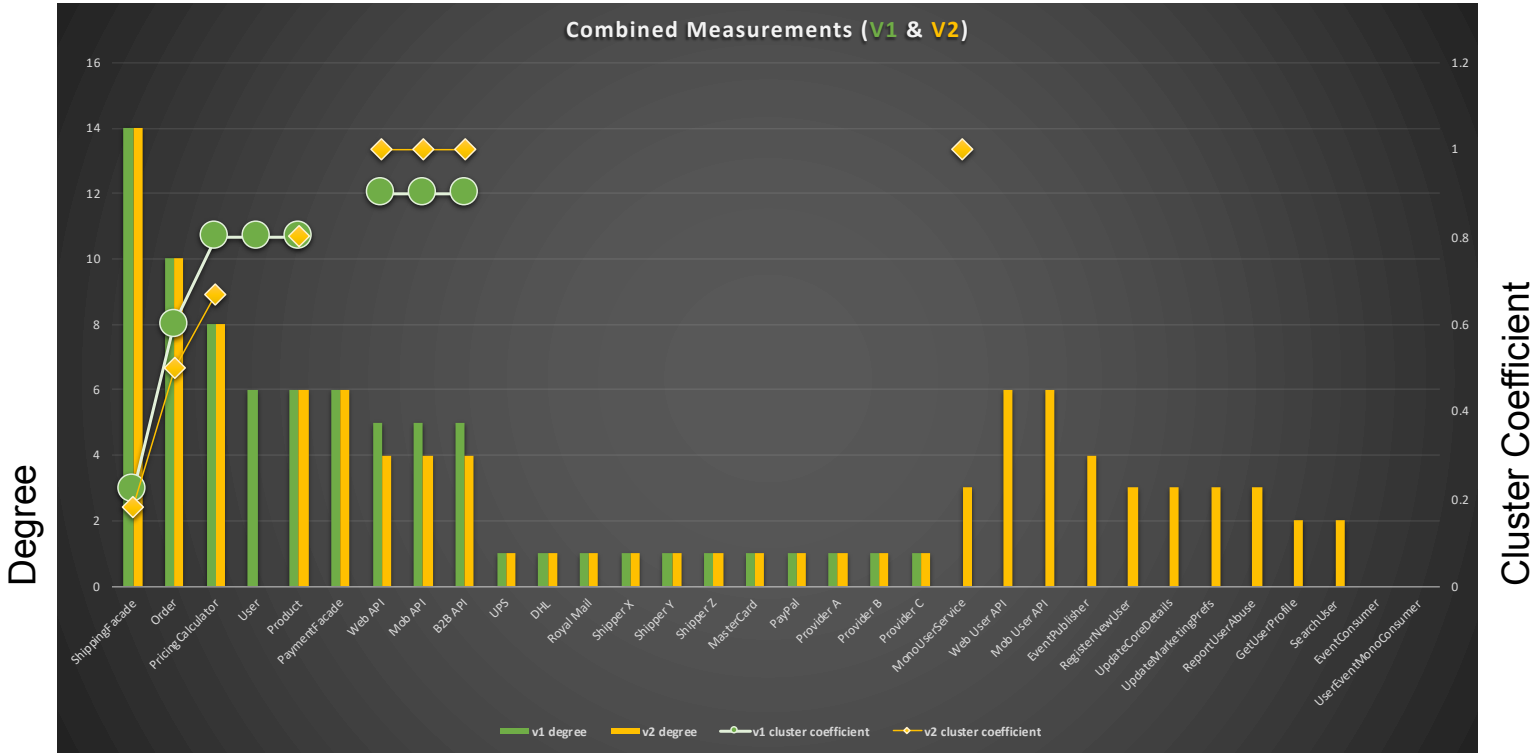
@techiewatt

COMPARING



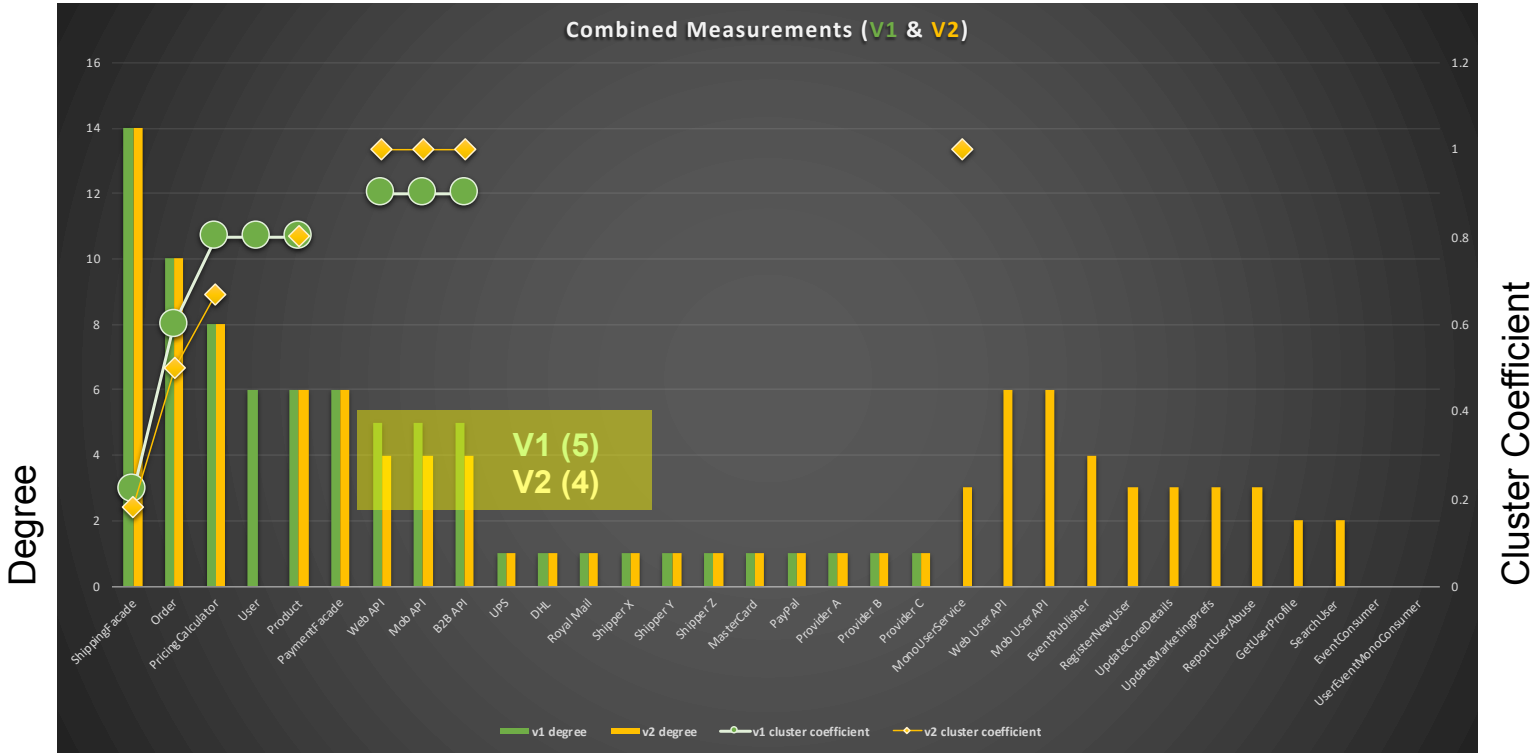
@techiewatt

COMPARING



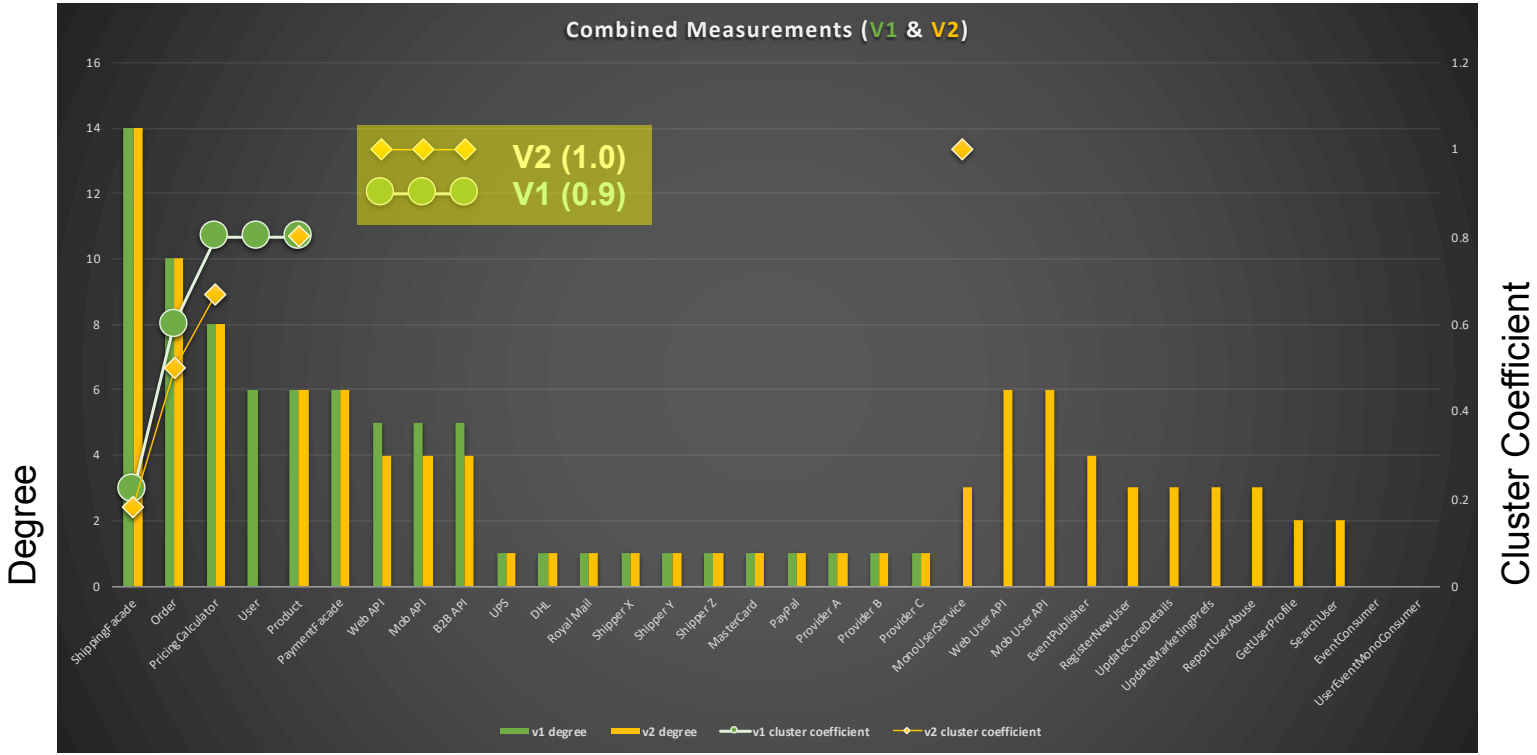
@techiewatt

COMPARING



@techiewatt

COMPARING



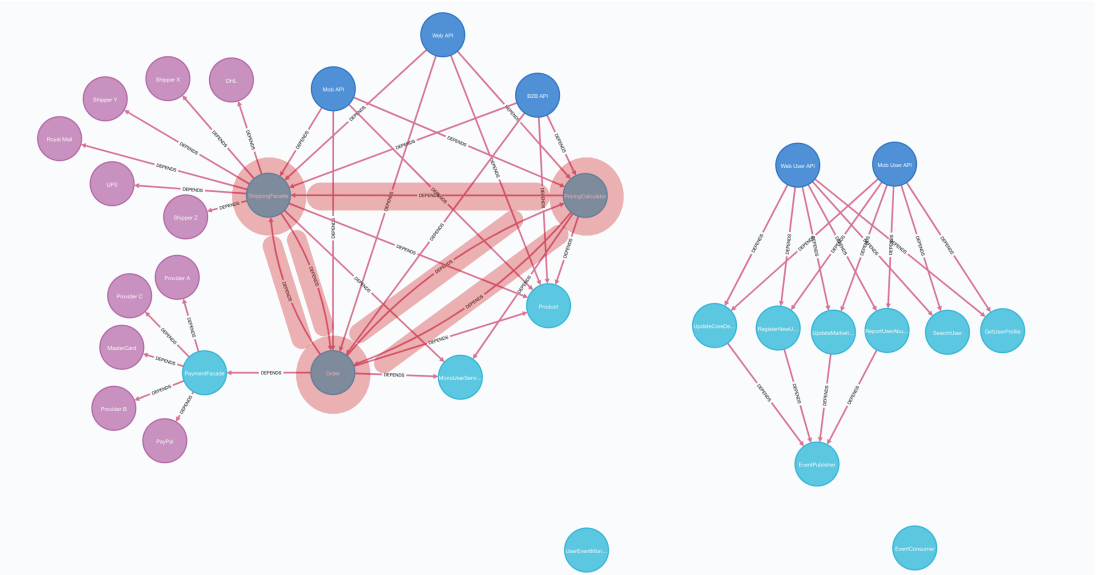
@techiewatt

FURTHER OPTIONS

OTHER MEASURES & ALGORITHMS

- **Strongly Connected Components (SCC)**

- Help detect circular dependencies



@techiewatt

OTHER MEASURES & ALGORITHMS

- **Path Finding Algorithms**
  Detect who is calling deprecated services

CONCLUSION

CONCLUSION

Early days …
Can’t be applied blindly …

Common sense and understanding of architectural approaches and patterns still required!!

HYPOTHESIS

General Hypothesis:
Data Driven Architectural Improvement

You can extract metrics and KPIs from a microservices architecture using graph theory
AND
use these to gain insight into the structure and characteristics of your microservices architecture


@techiewatt

HYPOTHESIS

General Hypothesis:
Data Driven Architectural Improvement

You can extract metrics and KPIs from a microservices architecture using graph theory

AND

use these to gain insight into the structure and characteristics of your microservices architecture

HYPOTHESIS

Specifically

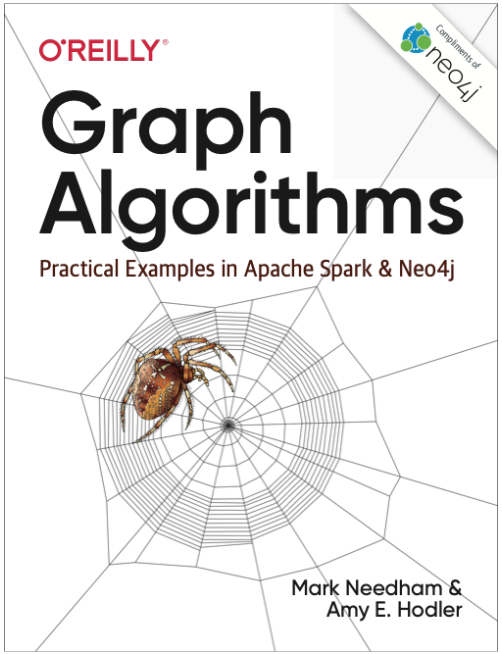
Can we use these metrics to detect bad microservice architectural smells and anti-patterns like a tightly coupled architecture (distributed monolith)?

CONCLUSION

Demonstrated using **degree** and **cluster coefficient** measures to **detect tightly coupled (distributed monolith) architectures**

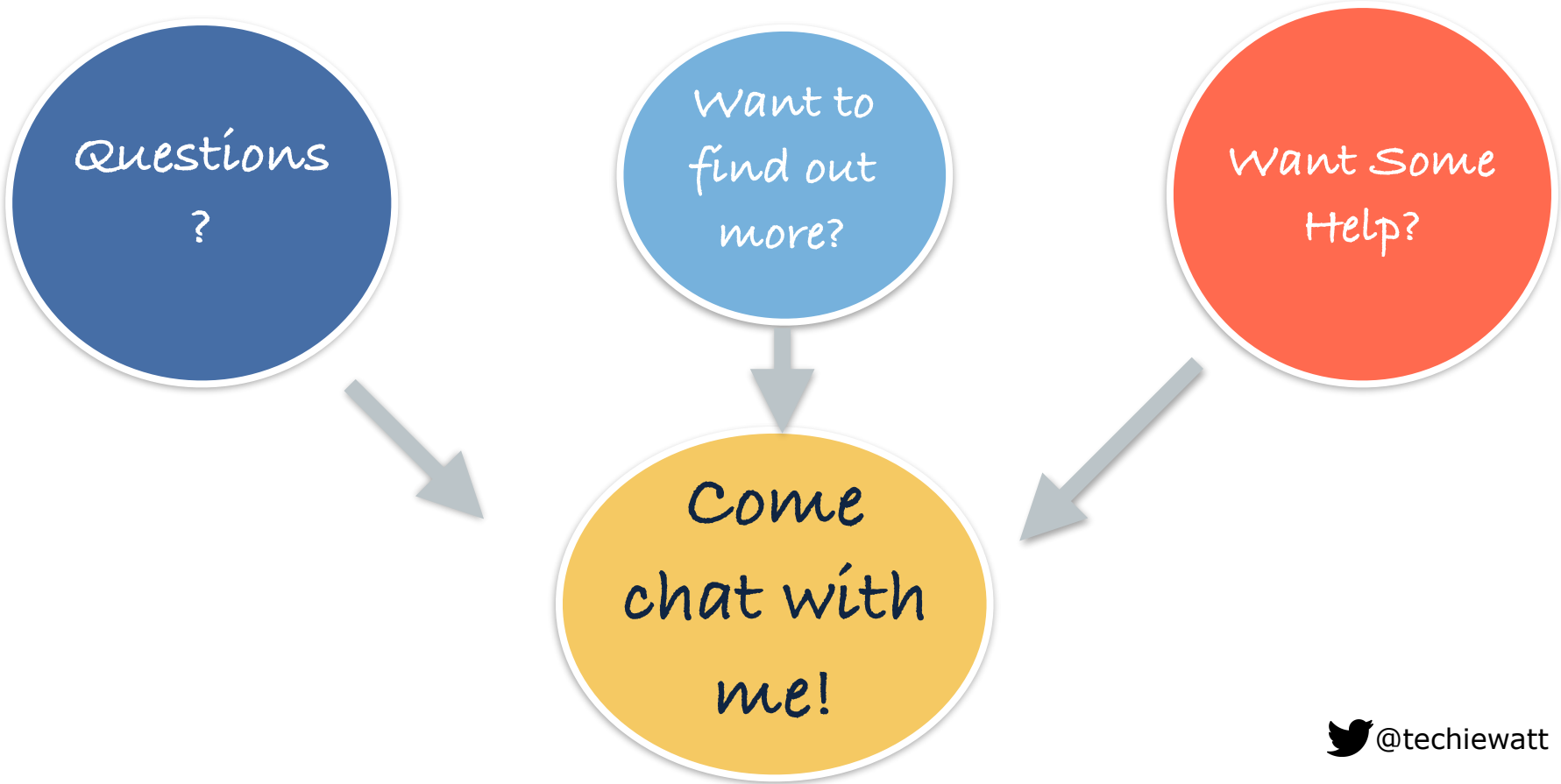
Demonstrated using **community detection algorithms** to **uncover related groupings (boundaries) of microservices**

RECOMMENDED LEARNING RESOURCES



@techiewatt

OpenCredo
A TRIFORK COMPANY



@techiewatt

goto; copenhagen

GOTO Copenhagen 2019
Conference Nov. 18 - 20

Please

Remember to rate this session

Thank you!

Follow us @gotocph