facebook

Dr. NMS

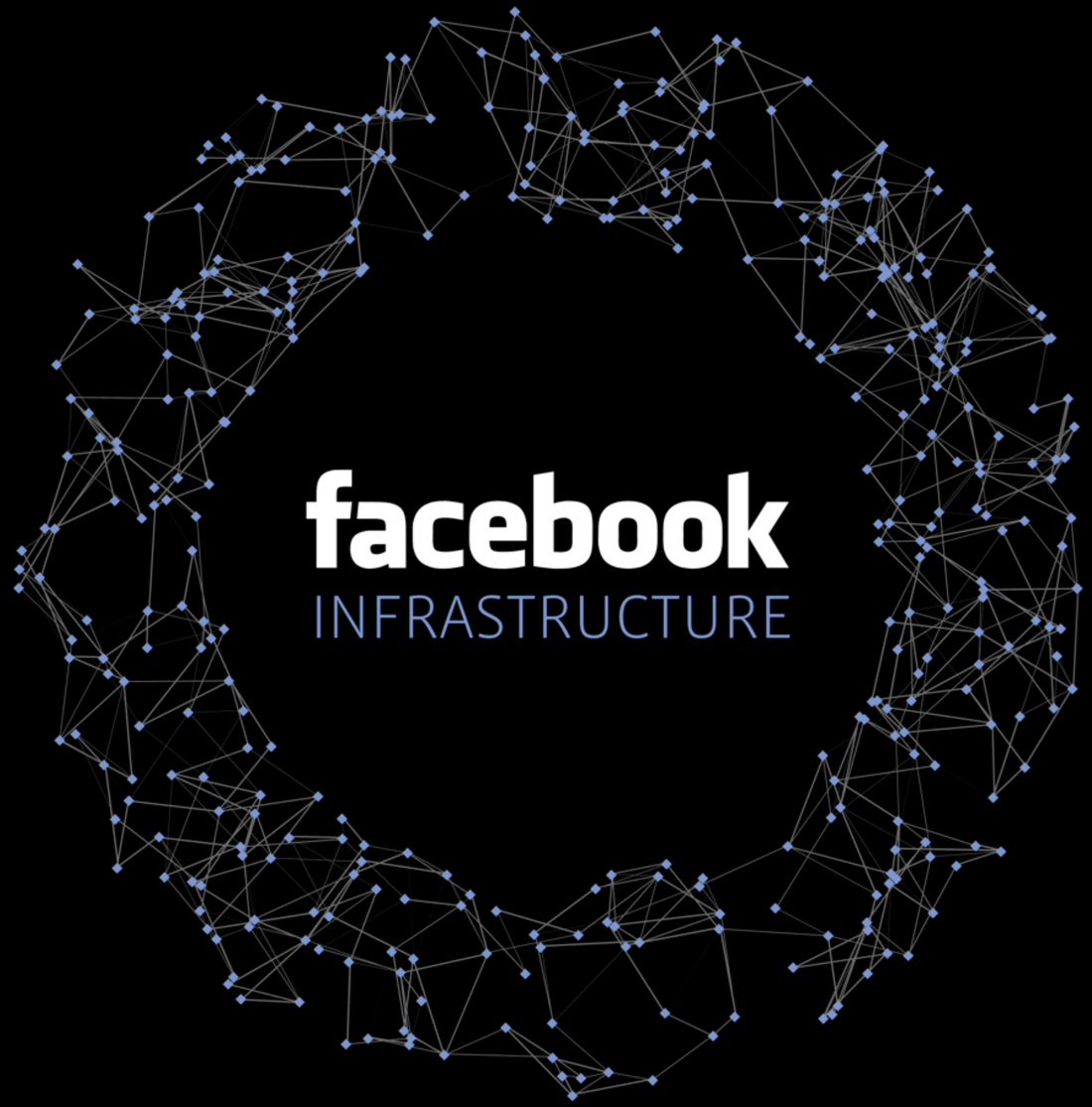
or: How Facebook Learned to Stop Worrying and Love the Network

Jose Leitao [jleitao@fb.com] & David Rothera [drothera@fb.com]

© 2015 Facebook | Dublin

© 2015 Facebook | Dublin | Credits: Photo by Jose Leitao - https://creativecommons.org/licenses/by/3.0/

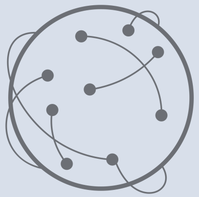
© 2015 Facebook | Dublin | Credits: Photo by Jose Leitao - https://creativecommons.org/licenses/by/3.0/



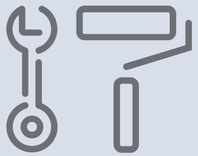
ZERO IMPACT NETWORK

© 2015 Facebook | Dublin

We'll be talking about



Facebook scale



FDN

Tales from the real world

This journey is 1% finished

Q&A

© 2015 Facebook | Dublin | Credits: network icon by Daniel Gamage https://thenounproject.com/term/network/49138/, tools icon by Kiryl Sytsko https://thenounproject.com/term/tools/122204/, chess icon by Dream Icons, https://thenounproject.com/term/chess/127867/, Paraglider by Matt Brooks https://thenounproject.com/term/paraglider/114410/, Question by Henrik Lund Mikkelsen https://thenounproject.com/term/question/8325/ https://creativecommons.org/licenses/by/3.0/

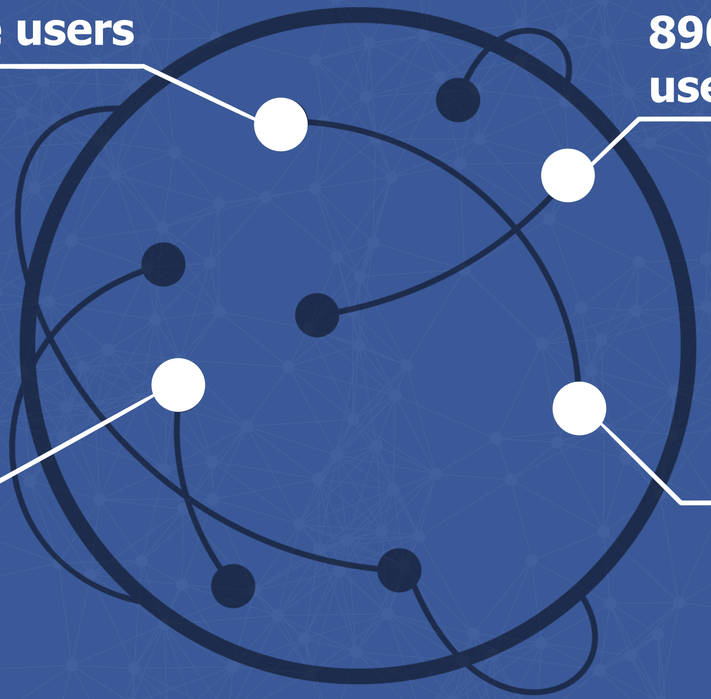
© 2015 Facebook | Dublin | Credits: Photo by Jose Leitao https://creativecommons.org/licenses/by/3.0/

Facebook scale

as of December 2014

1.19 billion mobile monthly active users

890 million daily active users on average



1.39 billion monthly active users

745 million mobile daily active users on average

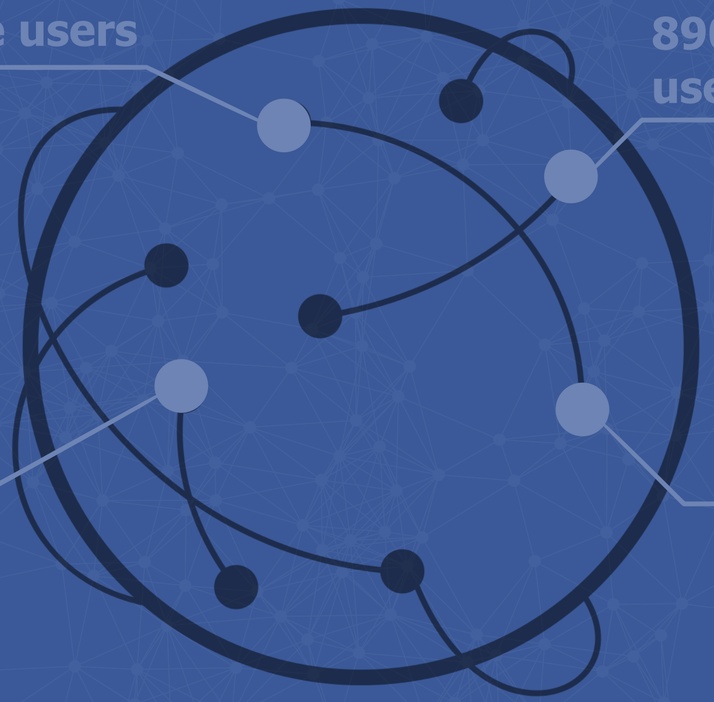
© 2015 Facebook | Dublin | Credit: Network icon by Daniel Gamage https://thenounproject.com/term/network/49138/ Public Domain

Facebook scale

as of December 2014

1.19 billion mobile monthly active users

890 million daily active users on average

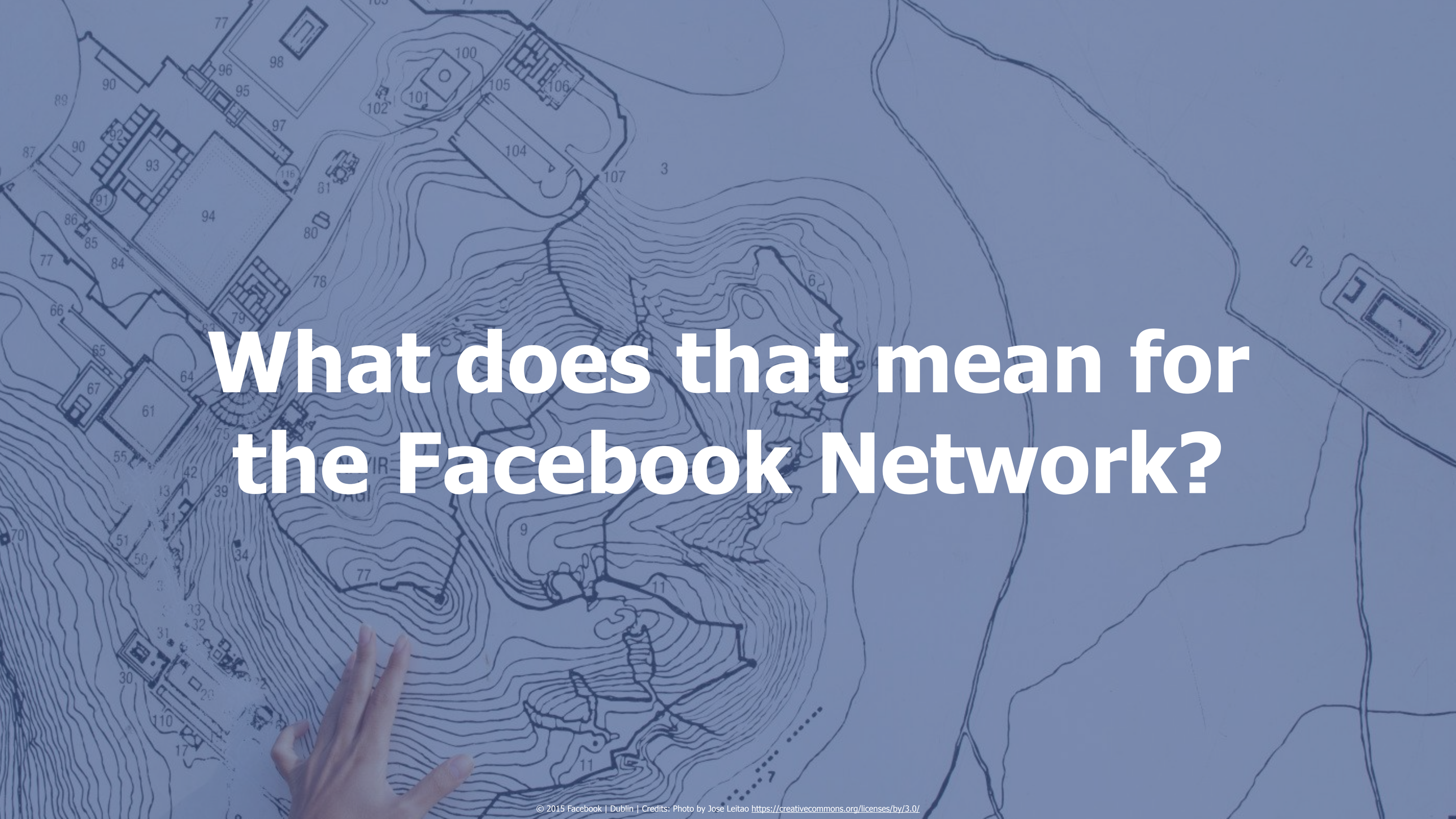


1.39 billion monthly active users

745 million mobile daily active users on average

Approximately 82.4% of our daily active users are outside the US and Canada

© 2015 Facebook | Dublin | Credit: Network icon by Daniel Gamage https://thenounproject.com/term/network/49138/ Public Domain

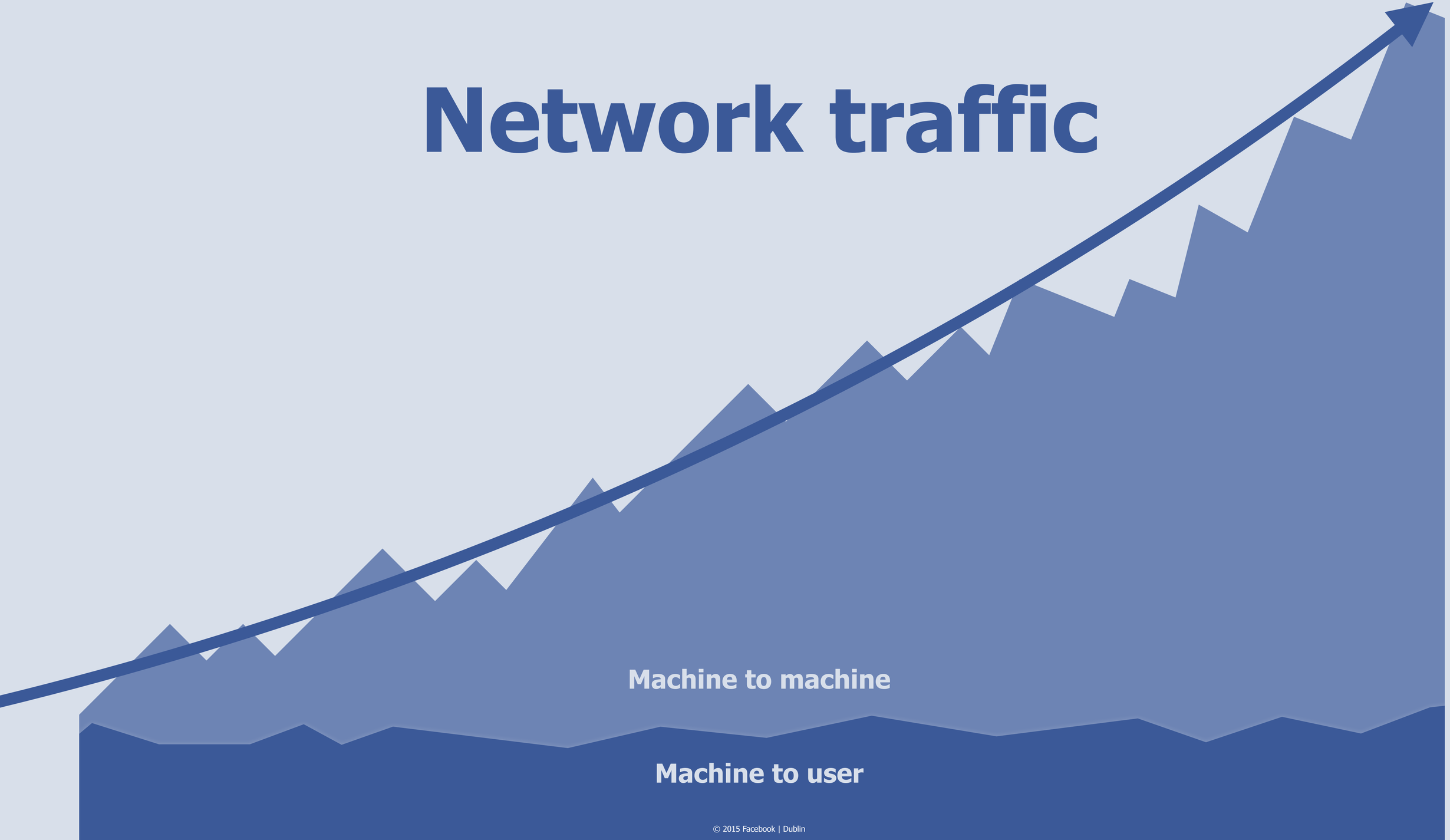


What does that mean for the Facebook Network?

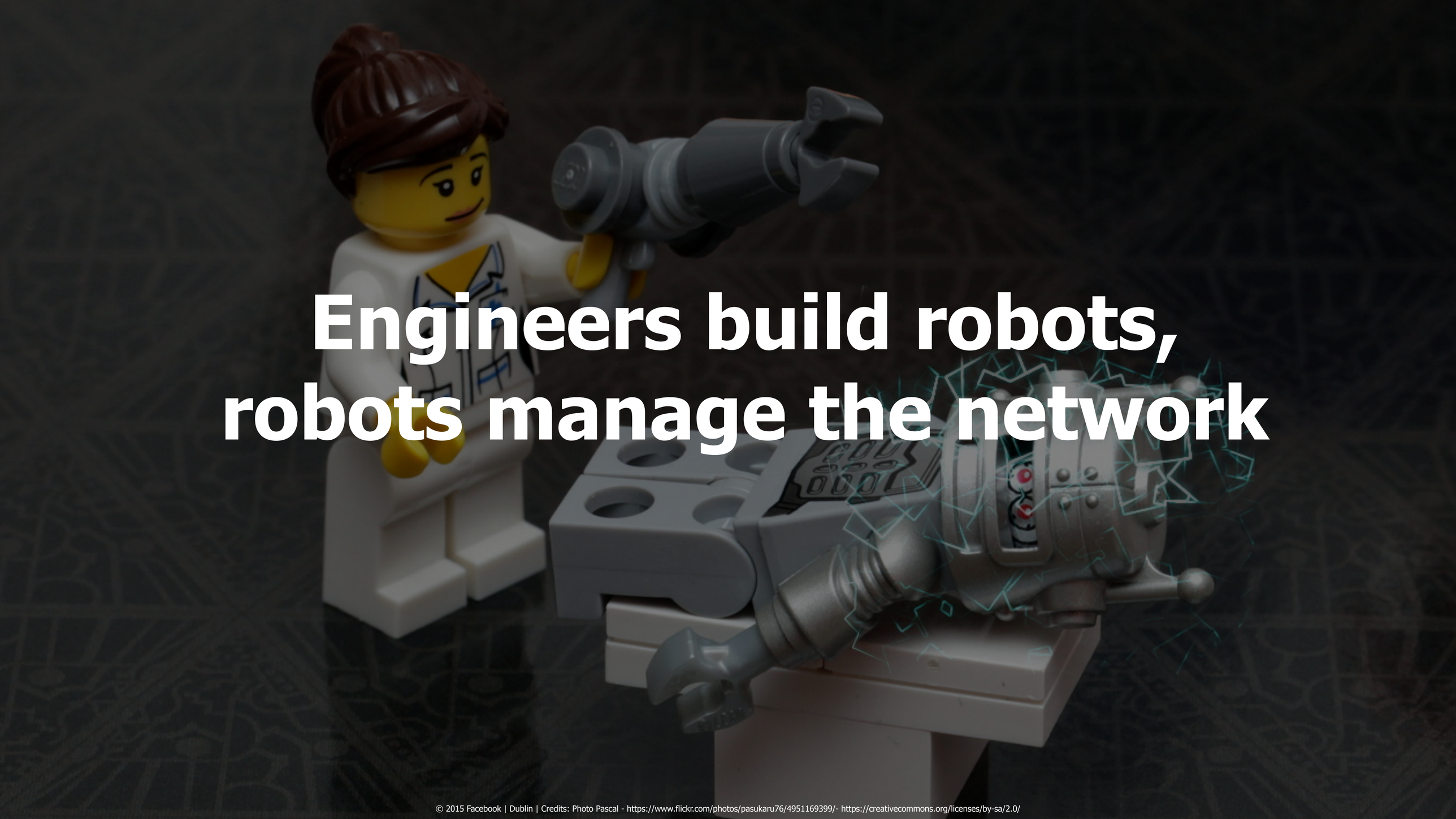
© 2015 Facebook | Dublin | Credits: Photo by Jose Leitao https://creativecommons.org/licenses/by/3.0/

© 2015 Facebook | Dublin | Credits: Photo by Jose Leitao https://creativecommons.org/licenses/by/3.0/

Network traffic



© 2015 Facebook | Dublin

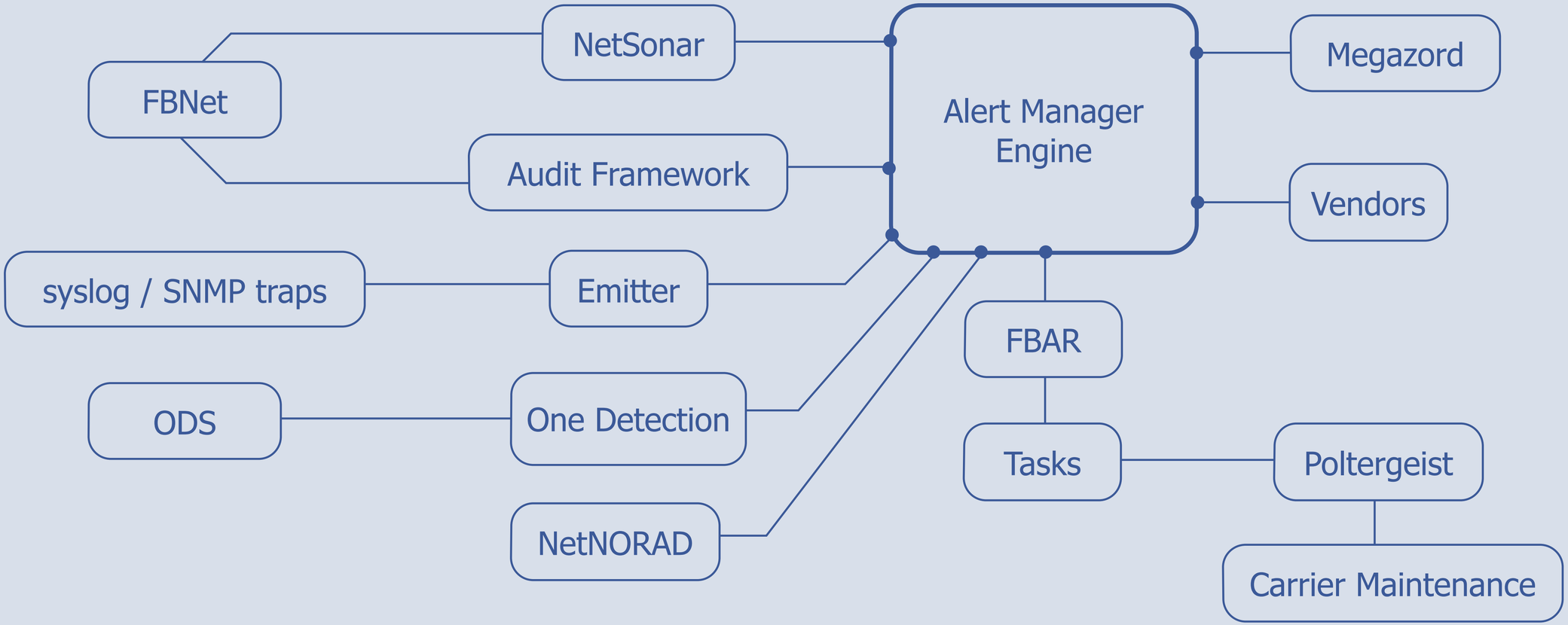


© 2015 Facebook | Dublin | Credits: Photo Pascal - https://www.flickr.com/photos/pasukaru76/4951169399/- https://creativecommons.org/licenses/by-sa/2.0/

Facebook Defined Networking

© 2015 Facebook | Dublin | Credits: Photo by Jose Leitao https://creativecommons.org/licenses/by/3.0/

Facebook Defined Networking



© 2015 Facebook | Dublin

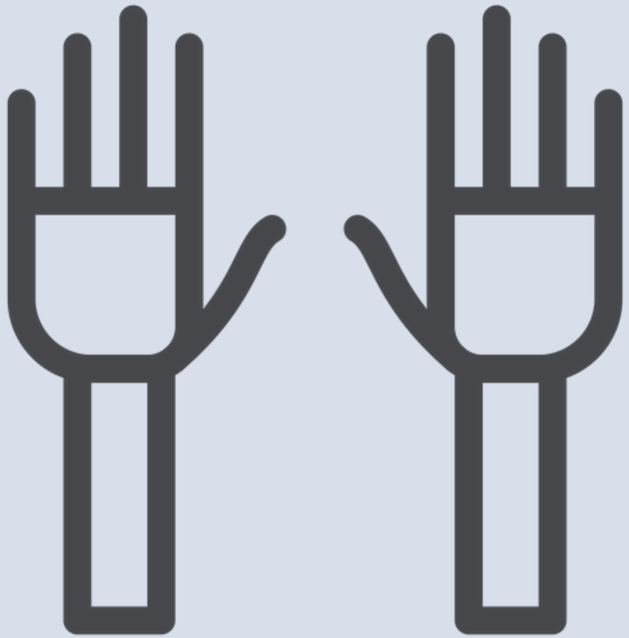
FBNet

The brains to help guide our robots run the network

© 2015 Facebook | Dublin | Credits: icon created by Rohith M S https://thenounproject.com/term/microchip/29013/ https://creativecommons.org/licenses/by/3.0/

Drain Services

The movers of traffic on the network devices



© 2015 Facebook | Dublin | Credits: icon created by iconsmind.com https://thenounproject.com/term/hands/67779/ https://creativecommons.org/licenses/by/3.0/

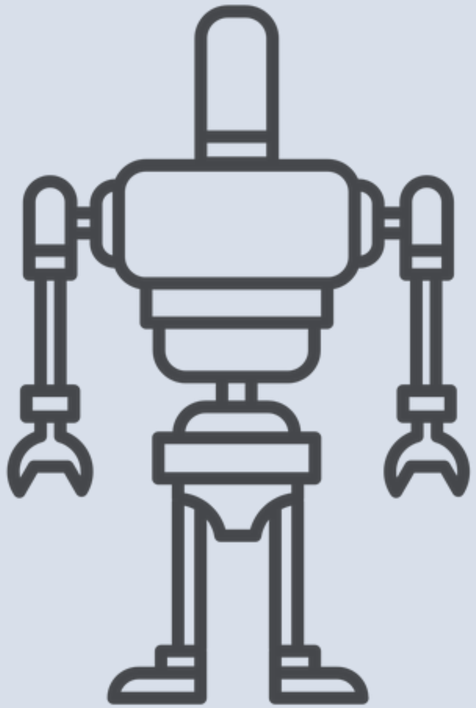
NetNORAD

Our Packet Loss detection system

© 2015 Facebook | Dublin | Credits: icon created by Pantelis Gkavos for https://thenounproject.com/term/radar/61238/ https://creativecommons.org/licenses/by/3.0/

Megazord

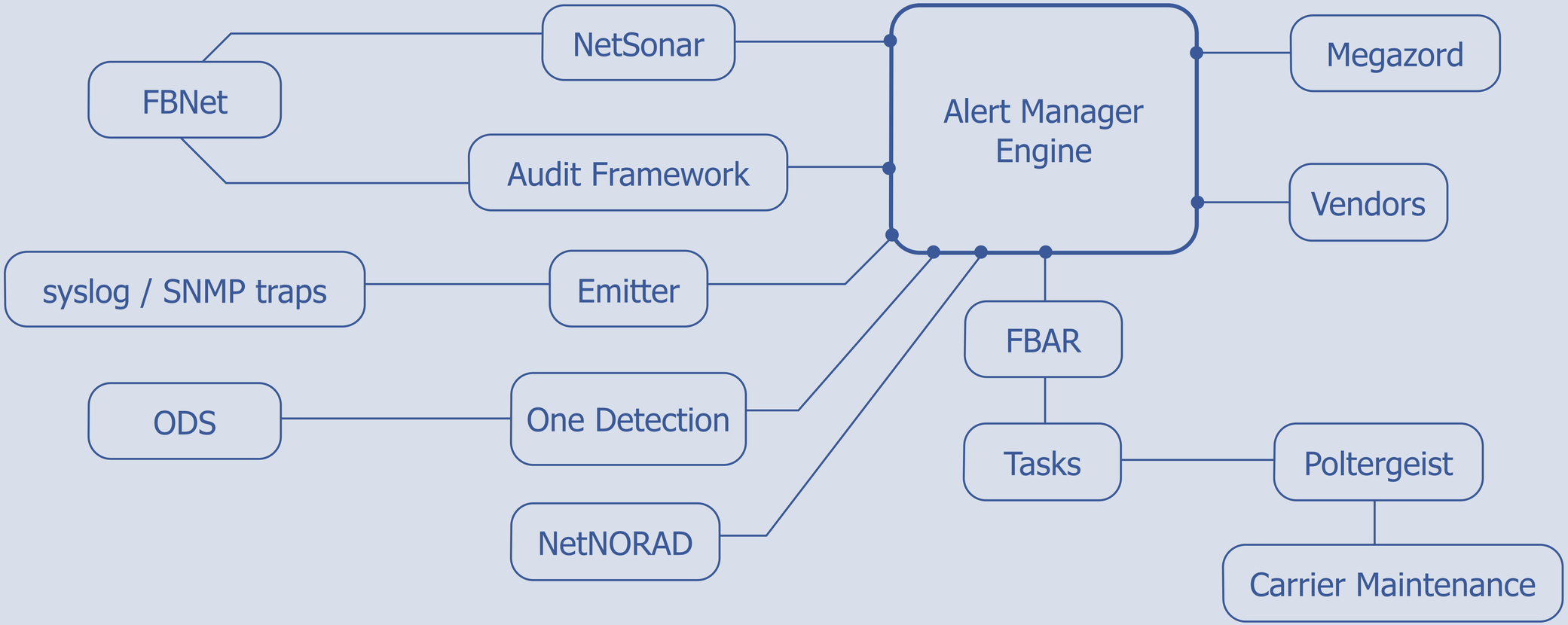
Our alarm correlation engine



© 2015 Facebook | Dublin | Credits: icon created by Gregory Sujkowski for https://thenounproject.com/term/robot/37319/ https://creativecommons.org/licenses/by/3.0/

Facebook Defined Networking

all components in action



© 2015 Facebook | Dublin

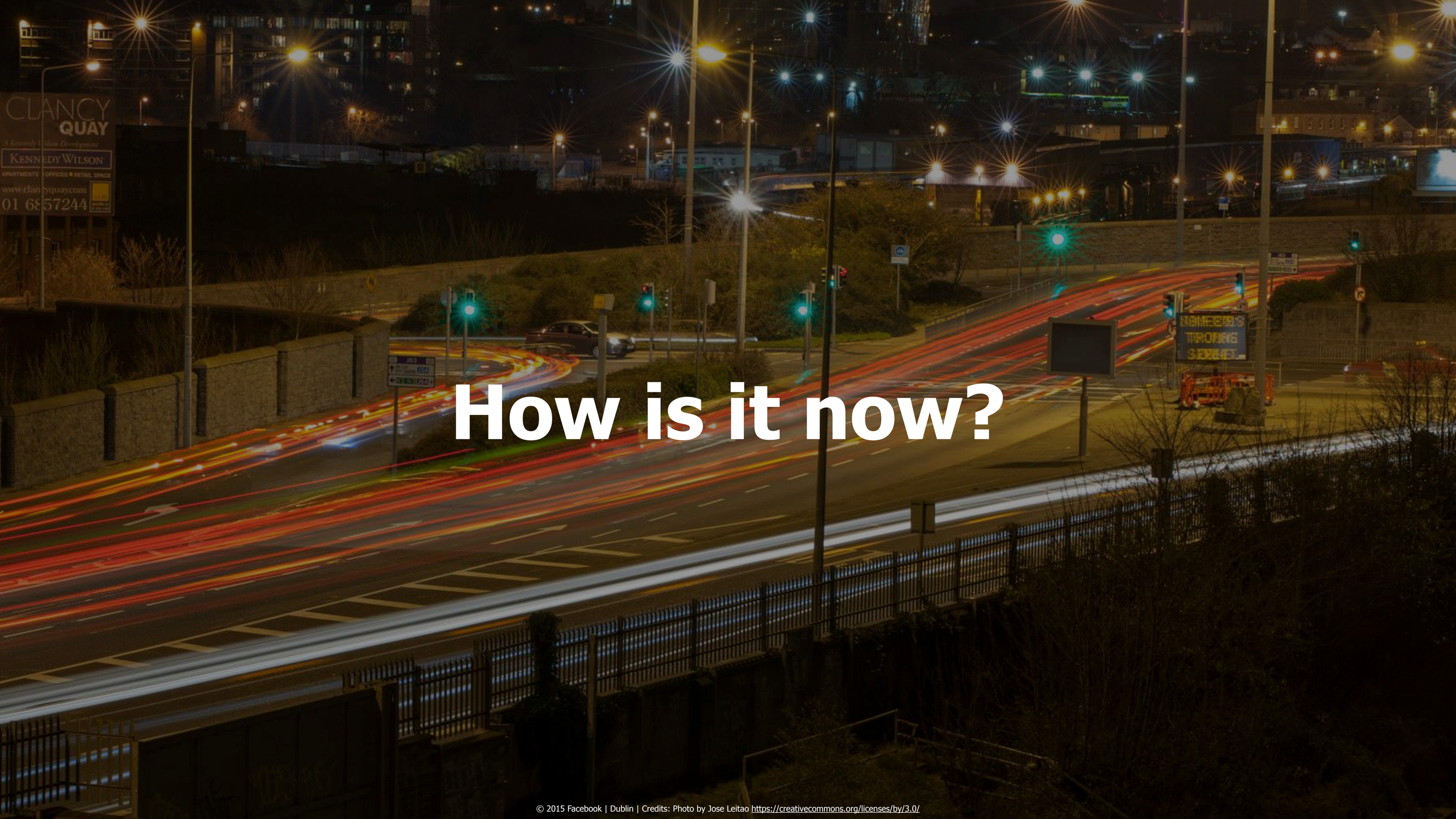
© 2015 Facebook | Dublin | Credits: Photo by Jose Leitao https://creativecommons.org/licenses/by/3.0/

Circuits @ scale

Manual approach

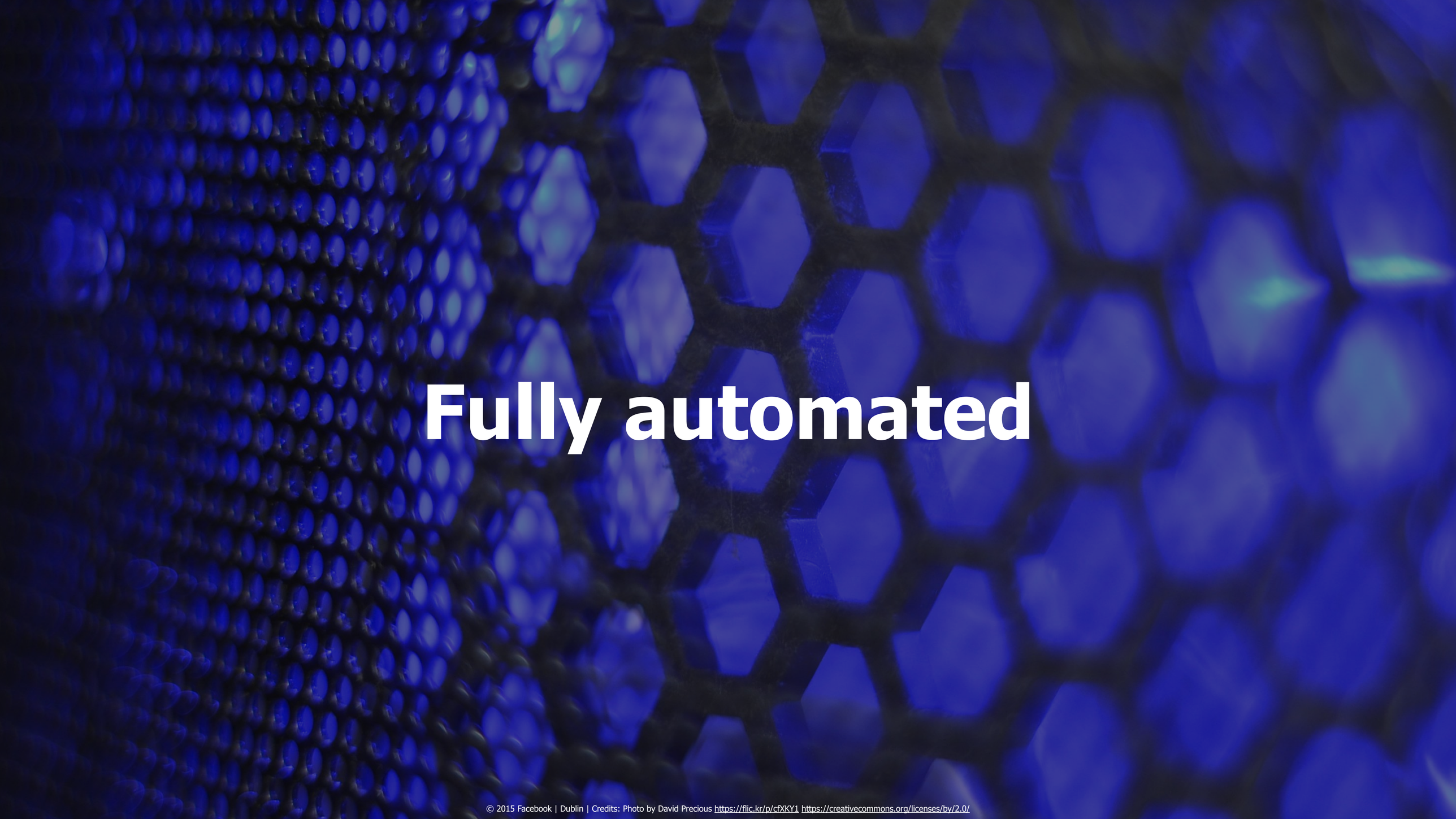
Hybrid approach

© 2015 Facebook | Dublin | chess icon by Dream Icons on https://thenounproject.com/term/chess/127867/ https://creativecommons.org/licenses/by/3.0/



How is it now?

© 2015 Facebook | Dublin | Credits: Photo by Jose Leitao https://creativecommons.org/licenses/by/3.0/



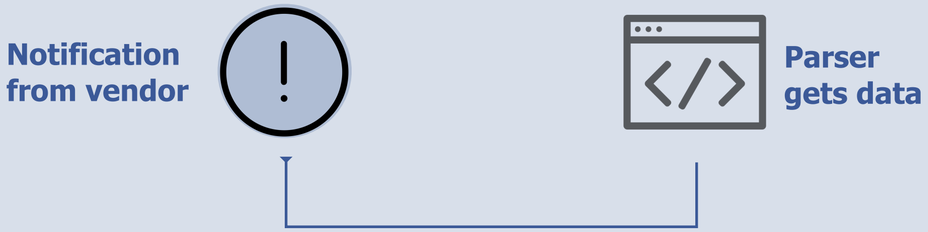
© 2015 Facebook | Dublin | Credits: Photo by David Precious https://flic.kr/p/cfXKY1 https://creativecommons.org/licenses/by/2.0/

How is it now?

Notification from vendor

© 2015 Facebook | Dublin | Credits: robot icon created by Alexander Wiefel https://thenounproject.com/term/robot/66176/, explosion icon created by inconsmind.com https://thenounproject.com/term/explosion/70006/, wrench by Musket https://thenounproject.com/term/wrench/117841/, code icon by Darren Barone https://thenounproject.com/term/code/21297/, check-list by Luboš Volkov https://thenounproject.com/term/check-list/20936/, hands created by iconsmind.com for https://thenounproject.com/term/hands/67779/ https://creativecommons.org/licenses/by/3.0/

How is it now?

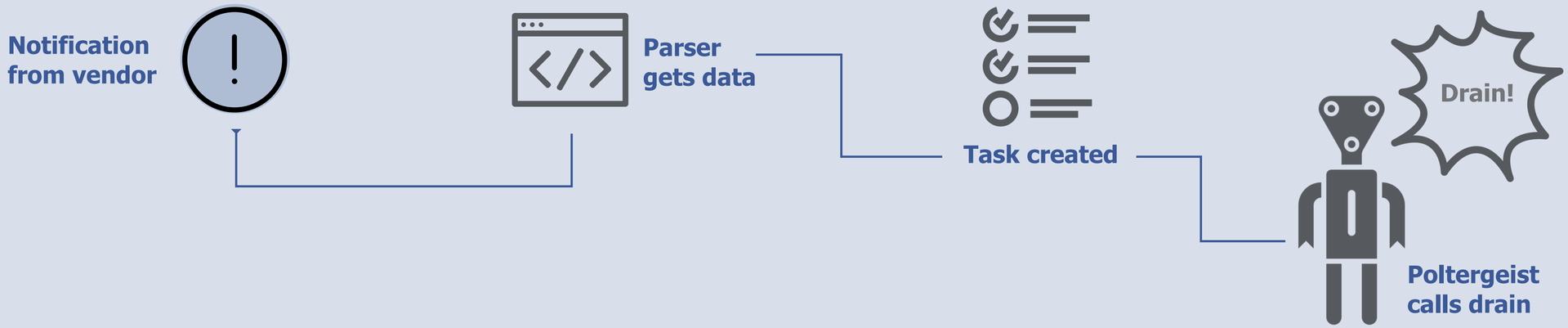


© 2015 Facebook | Dublin | Credits: robot icon created by Alexander Wiefel https://thenounproject.com/term/robot/66176/, explosion icon created by inconsmind.com https://thenounproject.com/term/explosion/70006/, wrench by Musket https://thenounproject.com/term/wrench/117841/, code icon by Darren Barone https://thenounproject.com/term/code/21297/, check-list by Luboš Volkov https://thenounproject.com/term/check-list/20936/, hands created by iconsmind.com for https://thenounproject.com/term/hands/67779/ https://creativecommons.org/licenses/by/3.0/

How is it now?

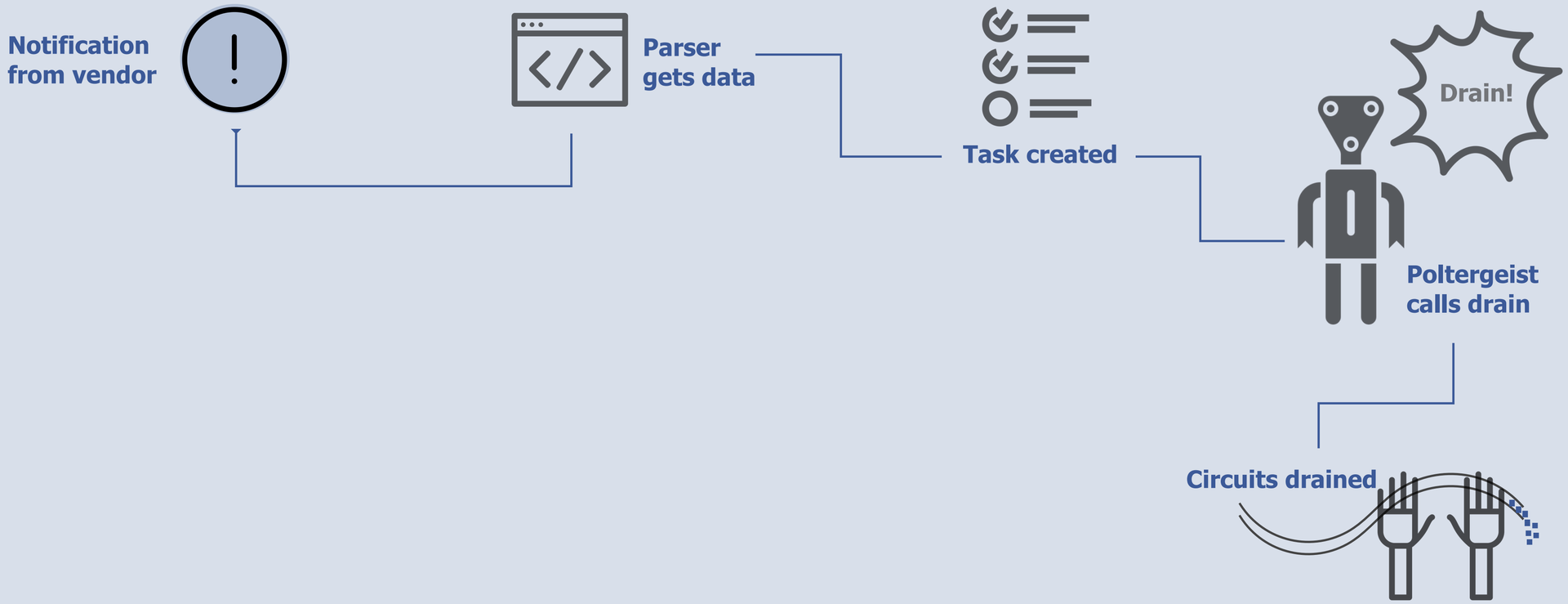
© 2015 Facebook | Dublin | Credits: robot icon created by Alexander Wiefel https://thenounproject.com/term/robot/66176/, explosion icon created by inconsmind.com https://thenounproject.com/term/explosion/70006/, wrench by Musket https://thenounproject.com/term/wrench/117841/, code icon by Darren Barone https://thenounproject.com/term/code/21297/, check-list by Luboš Volkov https://thenounproject.com/term/check-list/20936/, hands created by iconsmind.com for https://thenounproject.com/term/hands/67779/ https://creativecommons.org/licenses/by/3.0/

How is it now?



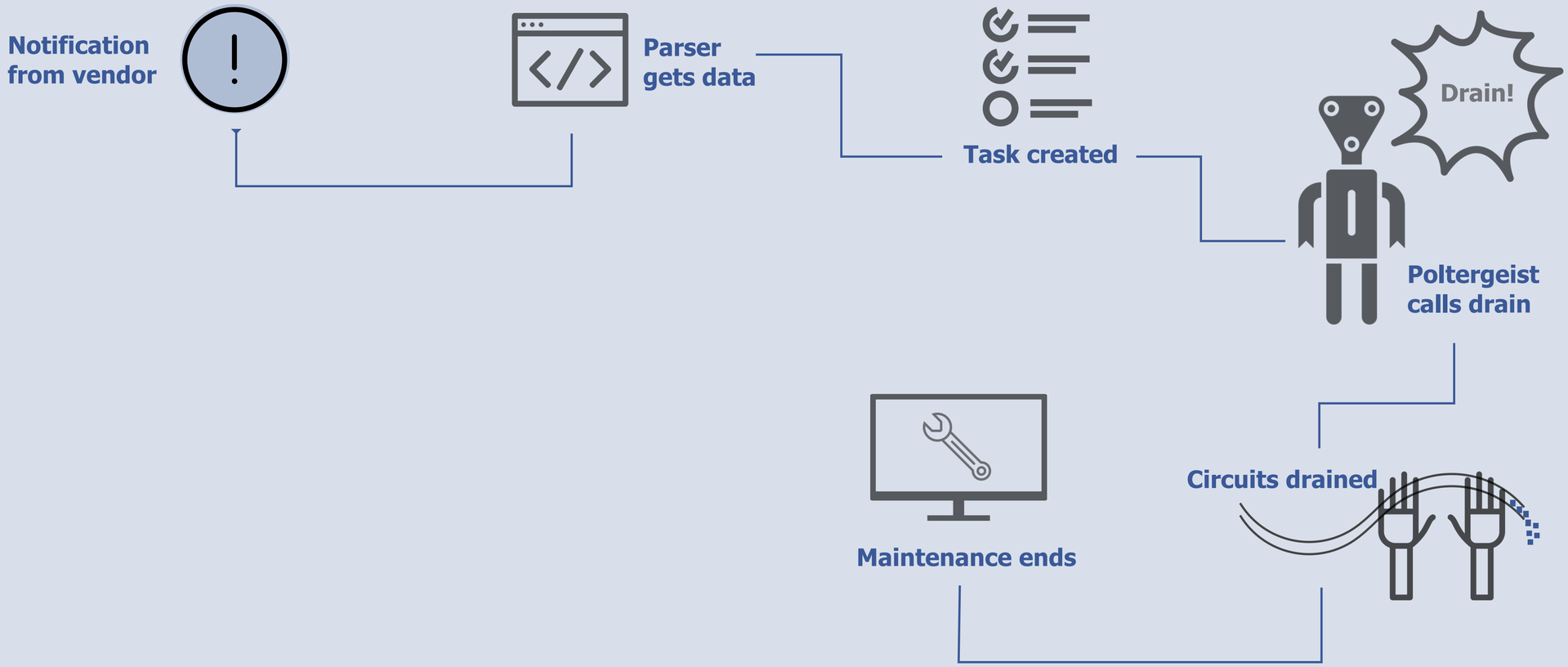
© 2015 Facebook | Dublin | Credits: robot icon created by Alexander Wiefel https://thenounproject.com/term/robot/66176/, explosion icon created by inconsmind.com https://thenounproject.com/term/explosion/70006/, wrench by Musket https://thenounproject.com/term/wrench/117841/, code icon by Darren Barone https://thenounproject.com/term/code/21297/, check-list by Luboš Volkov https://thenounproject.com/term/check-list/20936/, hands created by iconsmind.com for https://thenounproject.com/term/hands/67779/ https://creativecommons.org/licenses/by/3.0/

How is it now?



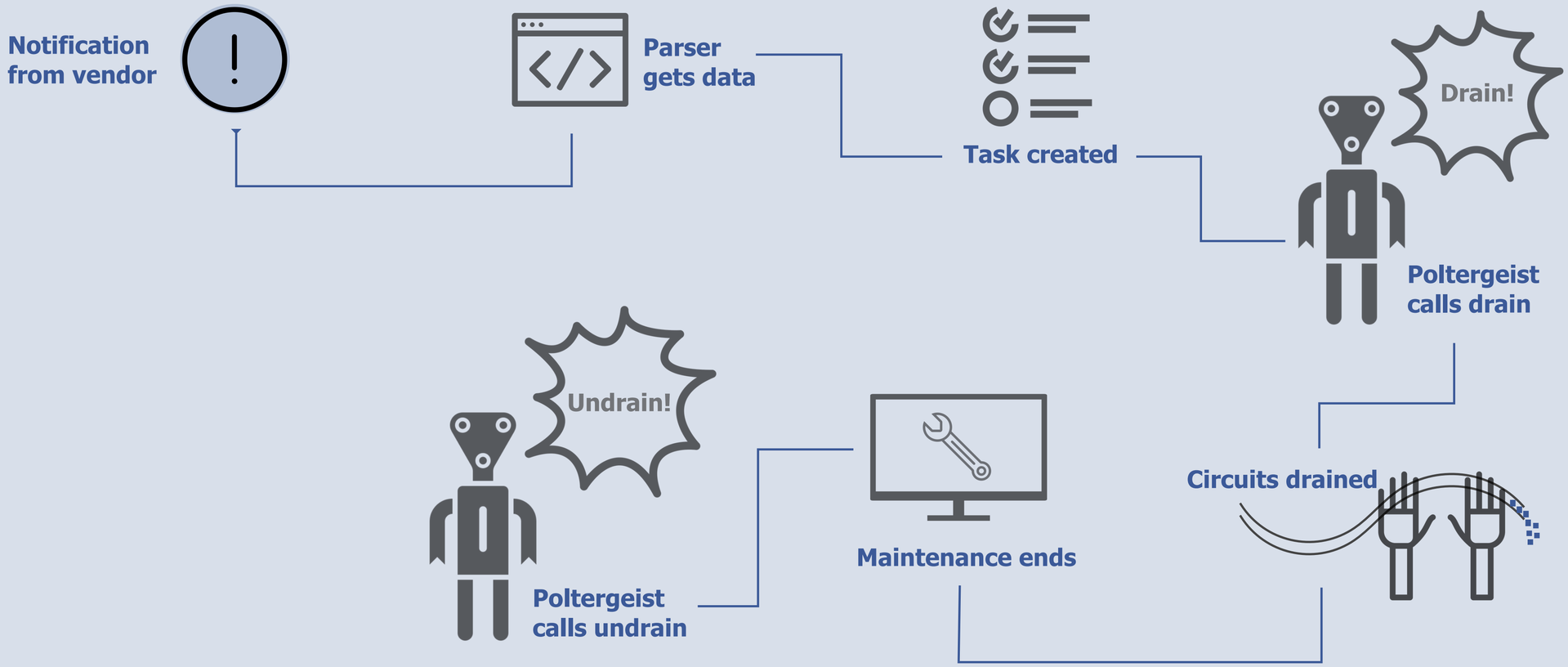
© 2015 Facebook | Dublin | Credits: robot icon created by Alexander Wiefel https://thenounproject.com/term/robot/66176/, explosion icon created by inconsmind.com https://thenounproject.com/term/explosion/70006/, wrench by Musket https://thenounproject.com/term/wrench/117841/, code icon by Darren Barone https://thenounproject.com/term/code/21297/, check-list by Luboš Volkov https://thenounproject.com/term/check-list/20936/, hands created by iconsmind.com for https://thenounproject.com/term/hands/67779/ https://creativecommons.org/licenses/by/3.0/

How is it now?



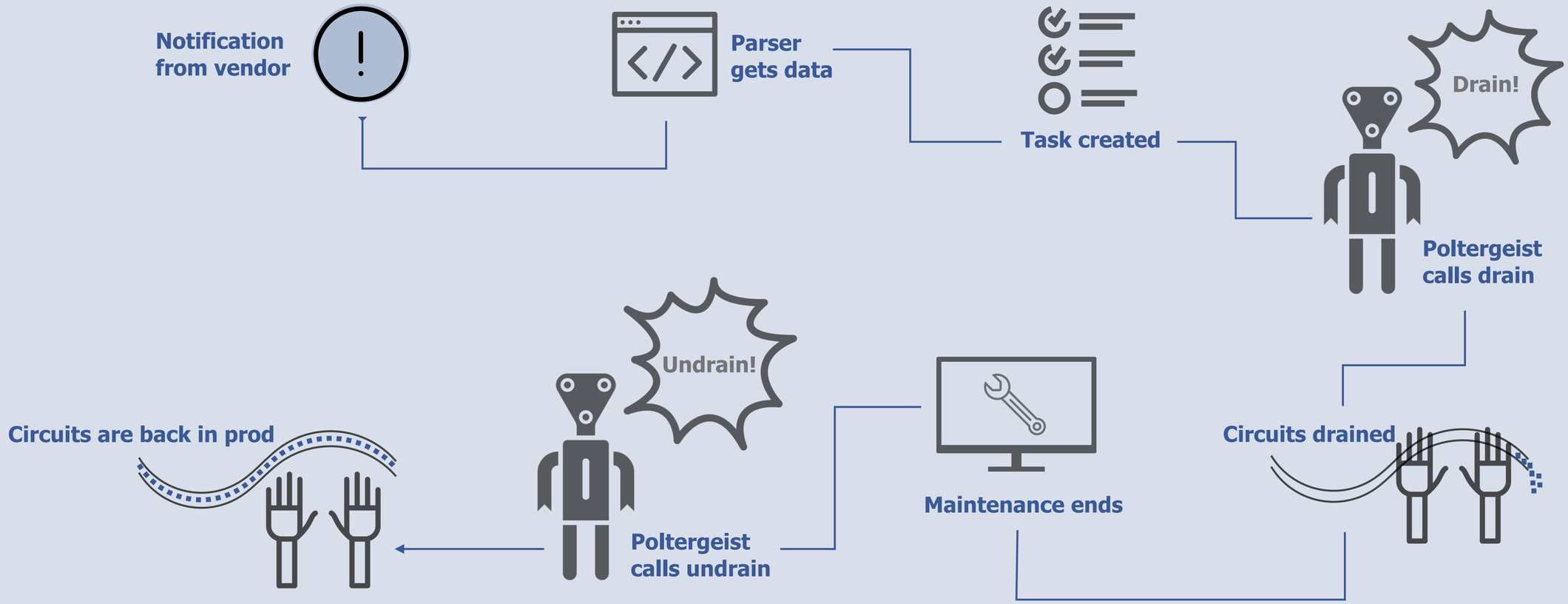
© 2015 Facebook | Dublin | Credits: robot icon created by Alexander Wiefel https://thenounproject.com/term/robot/66176/, explosion icon created by inconsmind.com https://thenounproject.com/term/explosion/70006/, wrench by Musket https://thenounproject.com/term/wrench/117841/, code icon by Darren Barone https://thenounproject.com/term/code/21297/, check-list by Luboš Volkov https://thenounproject.com/term/check-list/20936/, hands created by iconsmind.com for https://thenounproject.com/term/hands/67779/ https://creativecommons.org/licenses/by/3.0/

How is it now?



© 2015 Facebook | Dublin | Credits: robot icon created by Alexander Wiefel https://thenounproject.com/term/robot/66176/, explosion icon created by inconsmind.com https://thenounproject.com/term/explosion/70006/, wrench by Musket https://thenounproject.com/term/wrench/117841/, code icon by Darren Barone https://thenounproject.com/term/code/21297/, check-list by Luboš Volkov https://thenounproject.com/term/check-list/20936/, hands created by iconsmind.com for https://thenounproject.com/term/hands/67779/ https://creativecommons.org/licenses/by/3.0/

How is it now?



© 2015 Facebook | Dublin | Credits: robot icon created by Alexander Wiefel https://thenounproject.com/term/robot/66176/, explosion icon created by inconsmind.com https://thenounproject.com/term/explosion/70006/, wrench by Musket https://thenounproject.com/term/wrench/117841/, code icon by Darren Barone https://thenounproject.com/term/code/21297/, check-list by Luboš Volkov https://thenounproject.com/term/check-list/20936/, hands created by iconsmind.com for https://thenounproject.com/term/hands/67779/ https://creativecommons.org/licenses/by/3.0/

© 2015 Facebook | Dublin | Credits: photo by Ryan Espanto https://www.flickr.com/photos/ryn413/3952382779/ https://creativecommons.org/licenses/by/2.0/

Seriously…

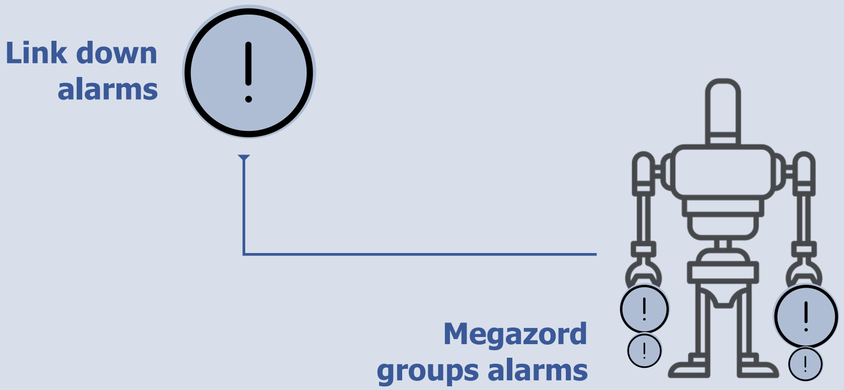
© 2015 Facebook | Dublin | Credits: photo by Ryan Espanto https://www.flickr.com/photos/ryn413/3952382779/ https://creativecommons.org/licenses/by/2.0/ / source of animation: https://www.youtube.com/watch?v=XMxkRh7sx84

How is it now?

Link down alarms

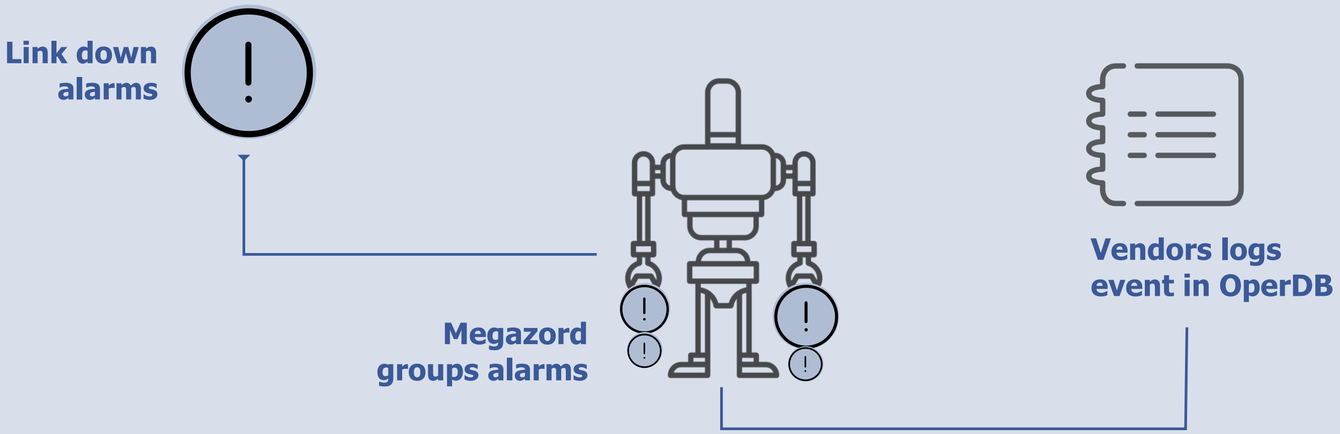
© 2015 Facebook | Dublin | Credits: robot icon created by Gregory Sujkowski for https://thenounproject.com/term/robot/37319/, list icon created by Stefano Vetere https://thenounproject.com/term/list/21440/, folder by Luis Mesinas https://thenounproject.com/term/folder/79694/, check-list by Luboš Volkov https://thenounproject.com/term/check-list/20936/, connected icon by Manav Dhiman https://thenounproject.com/term/connected/86082/, operator by Alice Cerconi https://thenounproject.com/term/conference-call/41544/, brain created by Rohith M S for https://thenounproject.com/term/microchip/29013/
https://creativecommons.org/licenses/by/3.0/

How is it now?



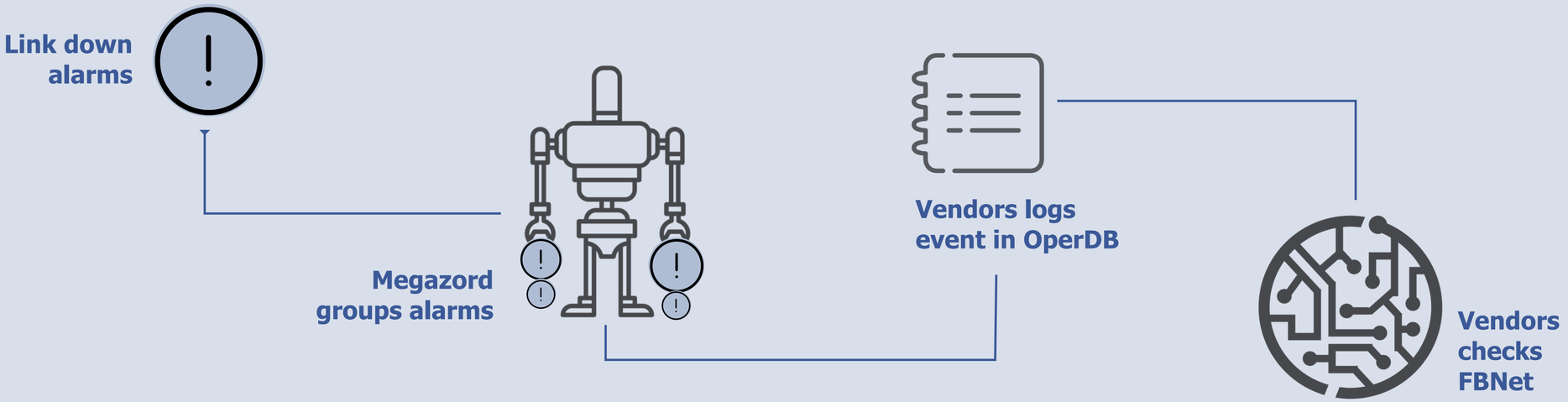
© 2015 Facebook | Dublin | Credits: robot icon created by Gregory Sujkowski for https://thenounproject.com/term/robot/37319/, list icon created by Stefano Vetere https://thenounproject.com/term/list/21440/, folder by Luis Mesinas https://thenounproject.com/term/folder/79694/, check-list by Luboš Volkov https://thenounproject.com/term/check-list/20936/, connected icon by Manav Dhiman https://thenounproject.com/term/connected/86082/, operator by Alice Cerconi https://thenounproject.com/term/conference-call/41544/, brain created by Rohith M S for https://thenounproject.com/term/microchip/29013/
https://creativecommons.org/licenses/by/3.0/

How is it now?



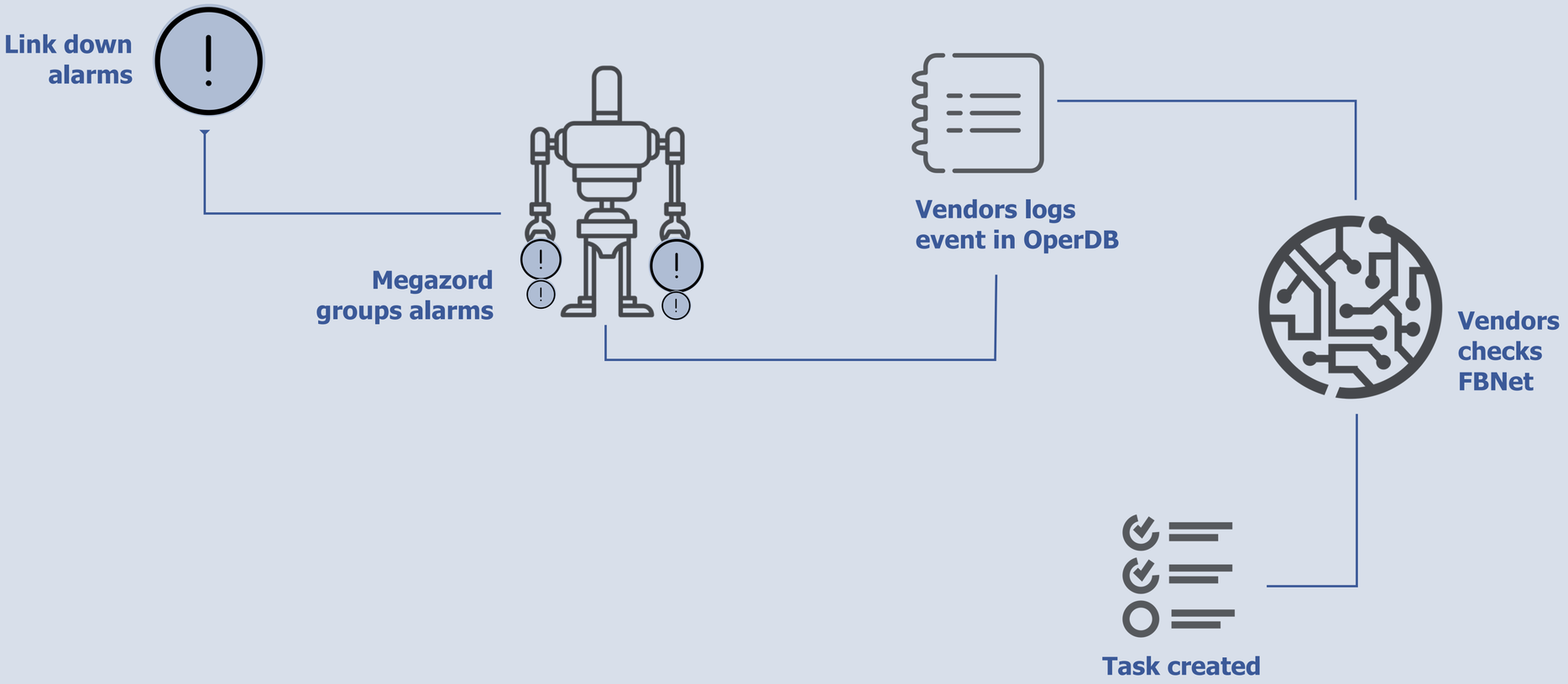
© 2015 Facebook | Dublin | Credits: robot icon created by Gregory Sujkowski for https://thenounproject.com/term/robot/37319/, list icon created by Stefano Vetere https://thenounproject.com/term/list/21440/, folder by Luis Mesinas https://thenounproject.com/term/folder/79694/, check-list by Luboš Volkov https://thenounproject.com/term/check-list/20936/, connected icon by Manav Dhiman https://thenounproject.com/term/connected/86082/, operator by Alice Cerconi https://thenounproject.com/term/conference-call/41544/, brain created by Rohith M S for https://thenounproject.com/term/microchip/29013/ https://creativecommons.org/licenses/by/3.0/

How is it now?



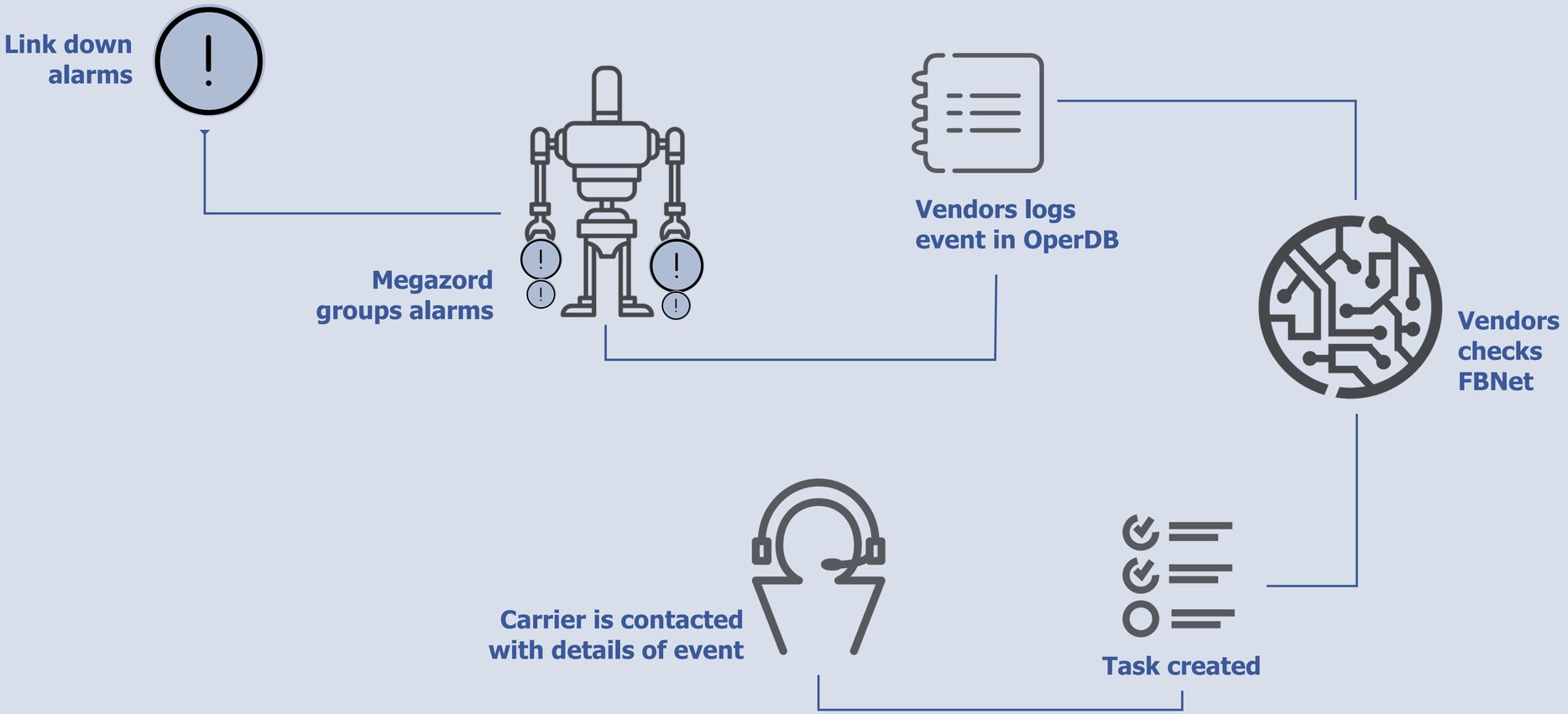
© 2015 Facebook | Dublin | Credits: robot icon created by Gregory Sujkowski for https://thenounproject.com/term/robot/37319/, list icon created by Stefano Vetere https://thenounproject.com/term/list/21440/, folder by Luis Mesinas https://thenounproject.com/term/folder/79694/, check-list by Luboš Volkov https://thenounproject.com/term/check-list/20936/, connected icon by Manav Dhiman https://thenounproject.com/term/connected/86082/, operator by Alice Cerconi https://thenounproject.com/term/conference-call/41544/, brain created by Rohith M S for https://thenounproject.com/term/microchip/29013/ https://creativecommons.org/licenses/by/3.0/

How is it now?



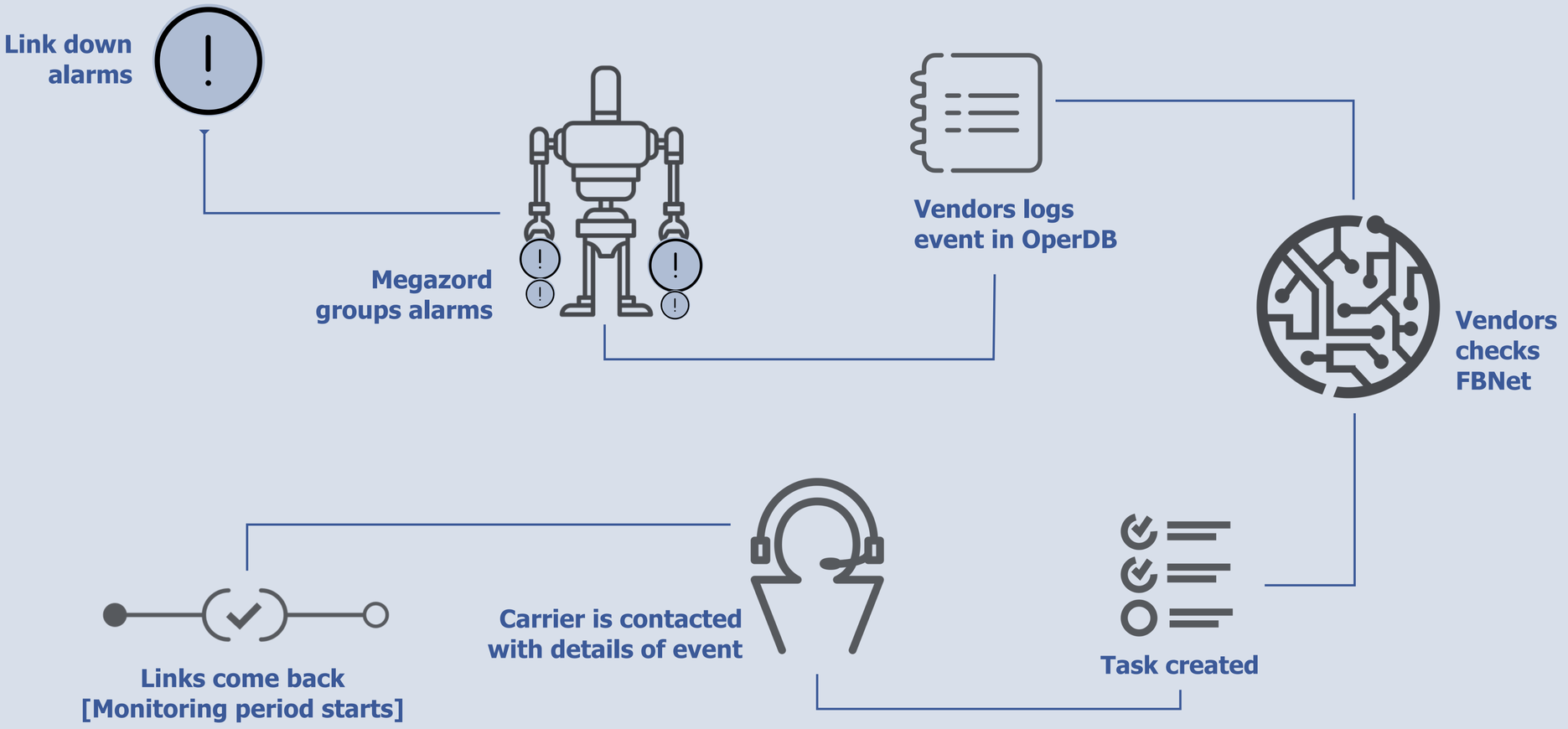
© 2015 Facebook | Dublin | Credits: robot icon created by Gregory Sujkowski for https://thenounproject.com/term/robot/37319/, list icon created by Stefano Vetere https://thenounproject.com/term/list/21440/, folder by Luis Mesinas https://thenounproject.com/term/folder/79694/, check-list by Luboš Volkov https://thenounproject.com/term/check-list/20936/, connected icon by Manav Dhiman https://thenounproject.com/term/connected/86082/, operator by Alice Cerconi https://thenounproject.com/term/conference-call/41544/, brain created by Rohith M S for https://thenounproject.com/term/microchip/29013/
https://creativecommons.org/licenses/by/3.0/

How is it now?



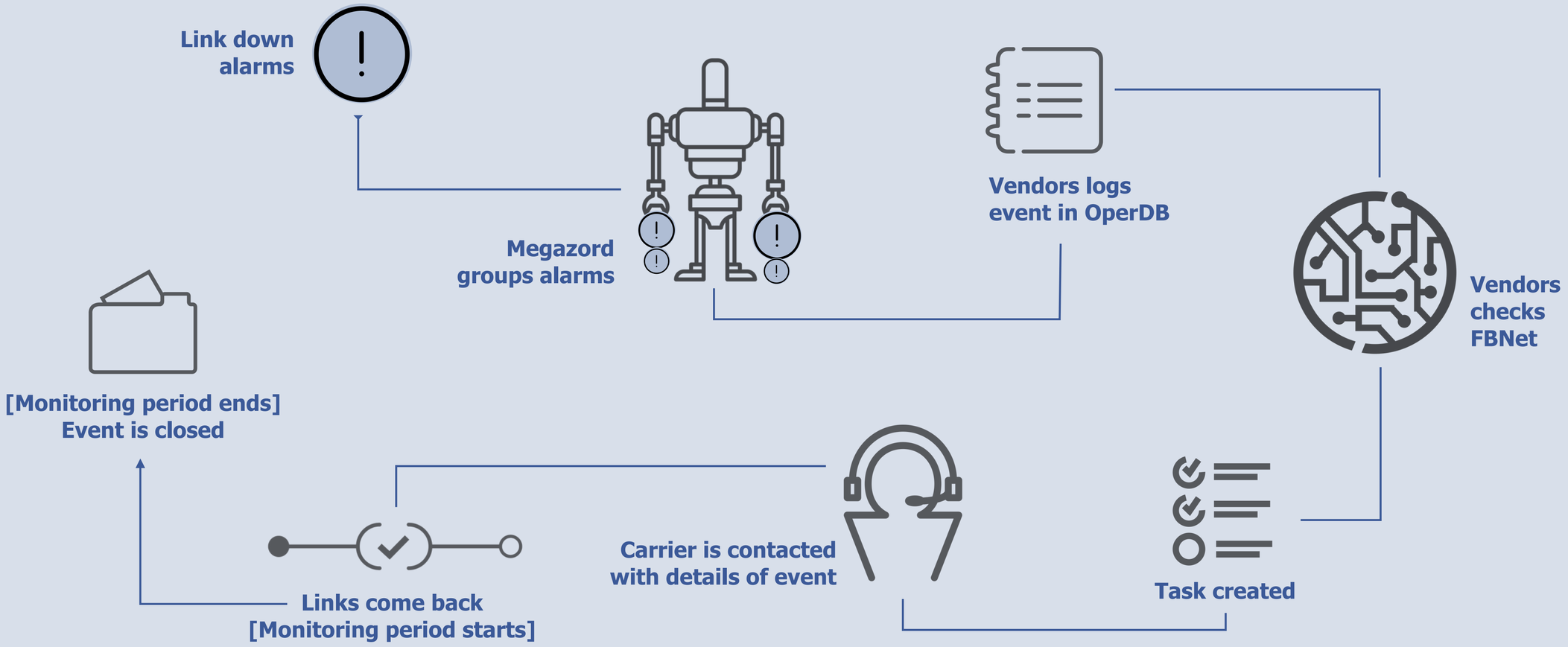
© 2015 Facebook | Dublin | Credits: robot icon created by Gregory Sujkowski for https://thenounproject.com/term/robot/37319/, list icon created by Stefano Vetere https://thenounproject.com/term/list/21440/, folder by Luis Mesinas https://thenounproject.com/term/folder/79694/, check-list by Luboš Volkov https://thenounproject.com/term/check-list/20936/, connected icon by Manav Dhiman https://thenounproject.com/term/connected/86082/, operator by Alice Cerconi https://thenounproject.com/term/conference-call/41544/, brain created by Rohith M S for https://thenounproject.com/term/microchip/29013/ https://creativecommons.org/licenses/by/3.0/

How is it now?



© 2015 Facebook | Dublin | Credits: robot icon created by Gregory Sujkowski for https://thenounproject.com/term/robot/37319/, list icon created by Stefano Vetere https://thenounproject.com/term/list/21440/, folder by Luis Mesinas https://thenounproject.com/term/folder/79694/, check-list by Luboš Volkov https://thenounproject.com/term/check-list/20936/, connected icon by Manav Dhiman https://thenounproject.com/term/connected/86082/, operator by Alice Cerconi https://thenounproject.com/term/conference-call/41544/, brain created by Rohith M S for https://thenounproject.com/term/microchip/29013/ https://creativecommons.org/licenses/by/3.0/

How is it now?



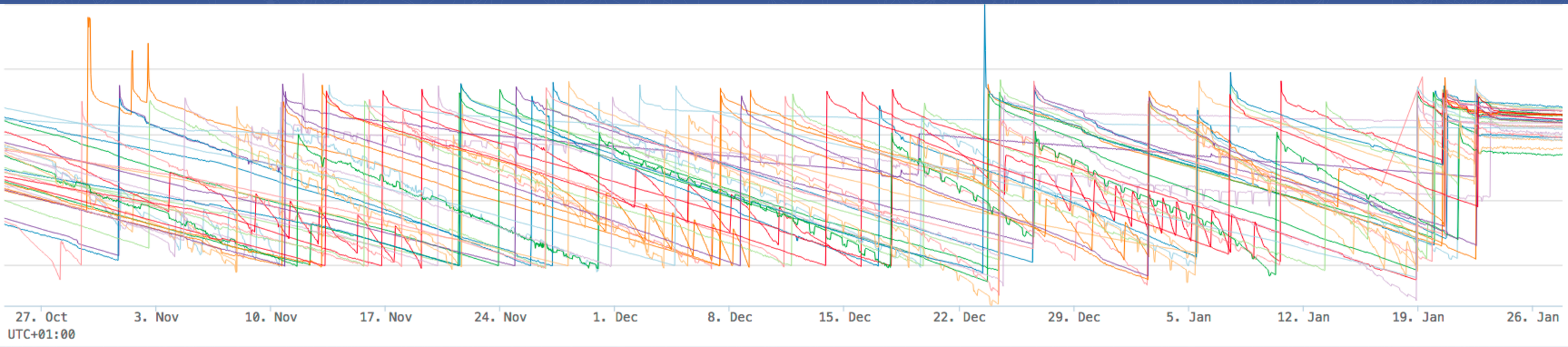
© 2015 Facebook | Dublin | Credits: robot icon created by Gregory Sujkowski for https://thenounproject.com/term/robot/37319/, list icon created by Stefano Vetere https://thenounproject.com/term/list/21440/, folder by Luis Mesinas https://thenounproject.com/term/folder/79694/, check-list by Luboš Volkov https://thenounproject.com/term/check-list/20936/, connected icon by Manav Dhiman https://thenounproject.com/term/connected/86082/, operator by Alice Cerconi https://thenounproject.com/term/conference-call/41544/, brain created by Rohith M S for https://thenounproject.com/term/microchip/29013/ https://creativecommons.org/licenses/by/3.0/

Handover

© 2015 Facebook | Dublin | Credits: Photo by Jose Leitao https://creativecommons.org/licenses/by/3.0/

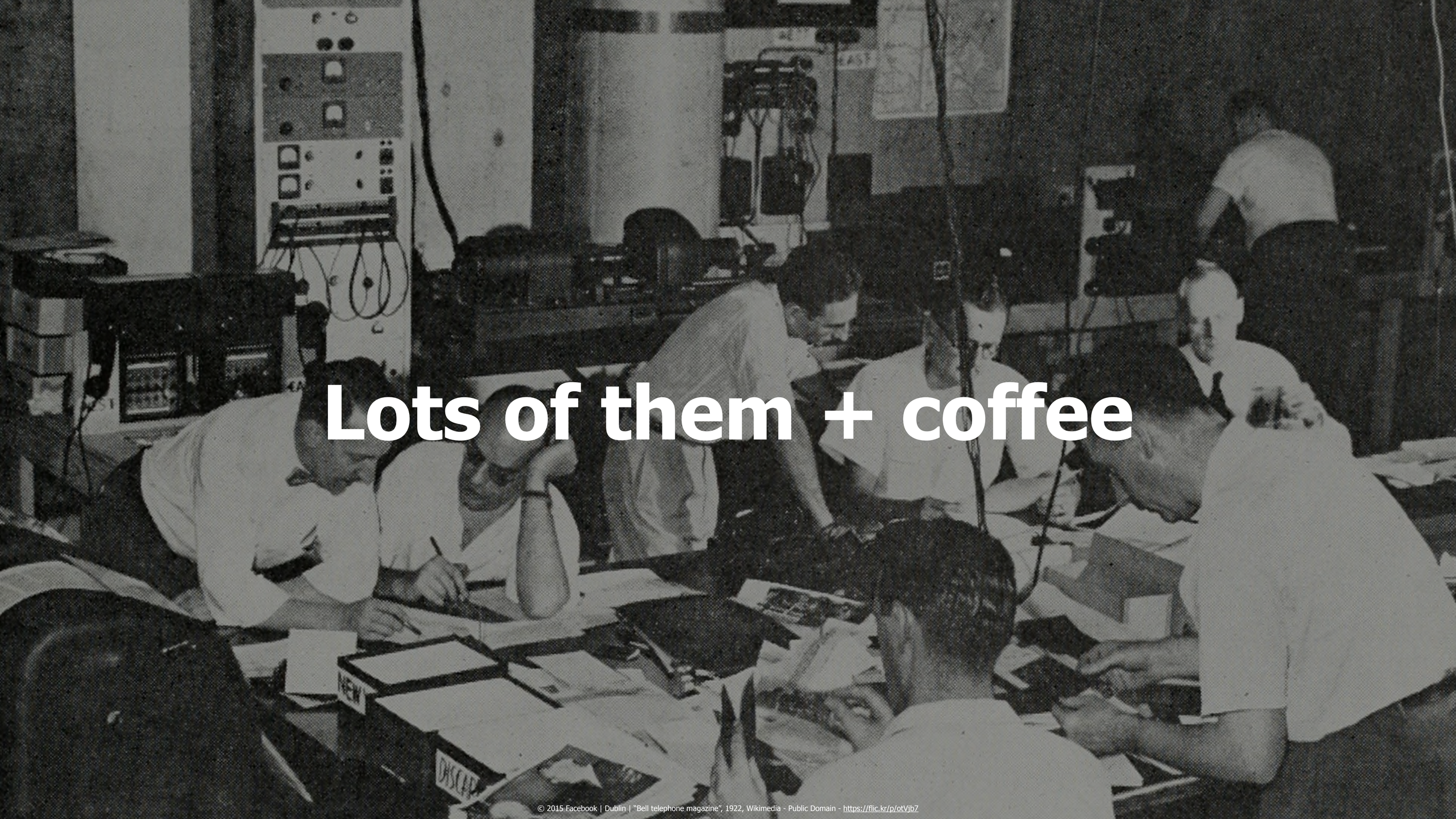
The memory leak debacle

Free memory over time



© 2015 Facebook | Dublin

© 2015 Facebook | Dublin | Raphael's "School of Athens", 1505, Wikimedia - Public Domain http://upload.wikimedia.org/wikipedia/commons/thumb/c/c3/Raphael_School_of_Athens.jpg/800px-Raphael_School_of_Athens.jpg



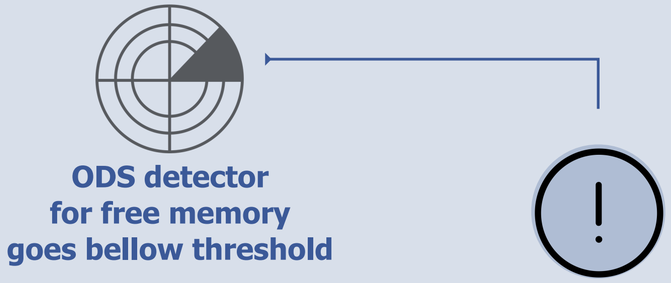
© 2015 Facebook | Dublin | “Bell telephone magazine”, 1922, Wikimedia - Public Domain - https://flic.kr/p/otVjb7

How is it now?

ODS detector for free memory goes bellow threshold

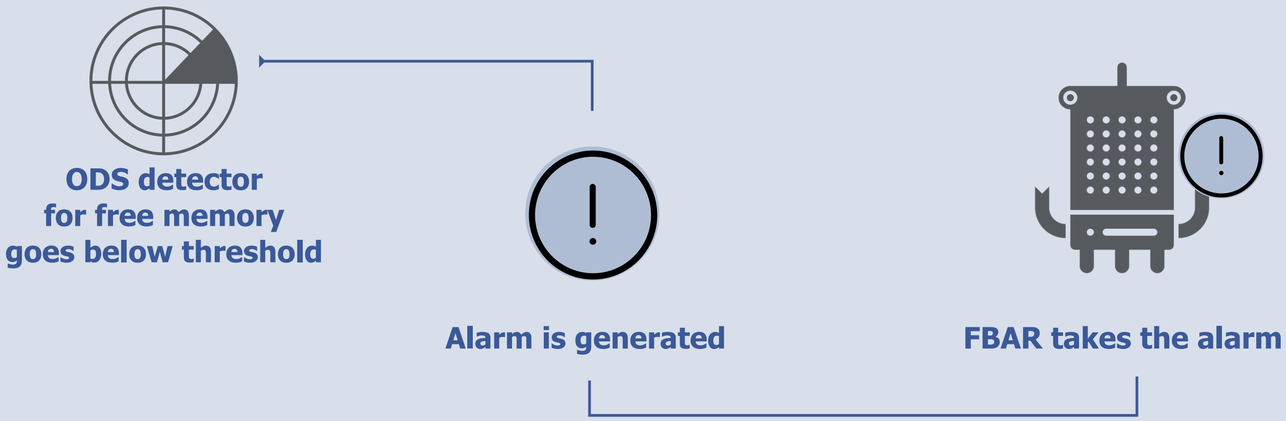
© 2015 Facebook | Dublin | Credits: radar by Harold Weaver https://thenounproject.com/term/radar/66335/, robot by Alexander Wiefel https://thenounproject.com/term/robot/65512/, explosion icon created by inconsmind.com https://thenounproject.com/term/explosion/70006,, server by Jevgeni Striganov https://thenounproject.com/term/server/57034/, check by useiconic.com https://thenounproject.com/term/server/57034/, loader by useiconic.com https://thenounproject.com/term/reload/45440/, code review by Arthur Shlain https://thenounproject.com/term/code-review/101170/, hands created by iconsmind.com for https://thenounproject.com/term/hands/67779/ https://creativecommons.org/licenses/by/3.0/

How is it now?



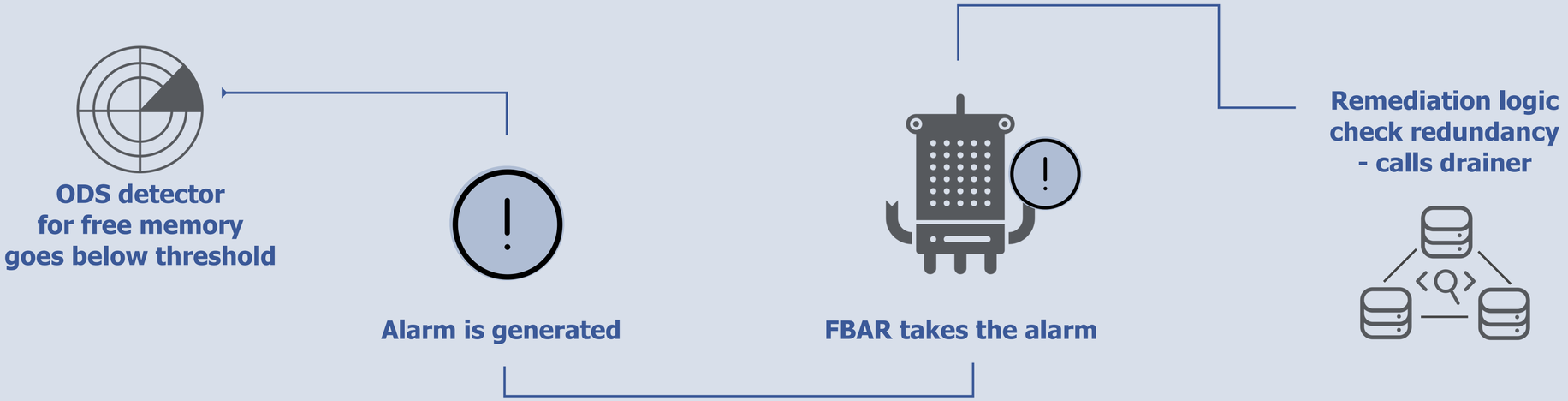
© 2015 Facebook | Dublin | Credits: radar by Harold Weaver https://thenounproject.com/term/radar/66335/, robot by Alexander Wiefel https://thenounproject.com/term/robot/65512/, explosion icon created by inconsmind.com https://thenounproject.com/term/explosion/70006,, server by Jevgeni Striganov https://thenounproject.com/term/server/57034/, check by useiconic.com https://thenounproject.com/term/server/57034/, loader by useiconic.com https://thenounproject.com/term/reload/45440/, code review by Arthur Shlain https://thenounproject.com/term/code-review/101170/, hands created by iconsmind.com for https://thenounproject.com/term/hands/67779/ https://creativecommons.org/licenses/by/3.0/

How is it now?



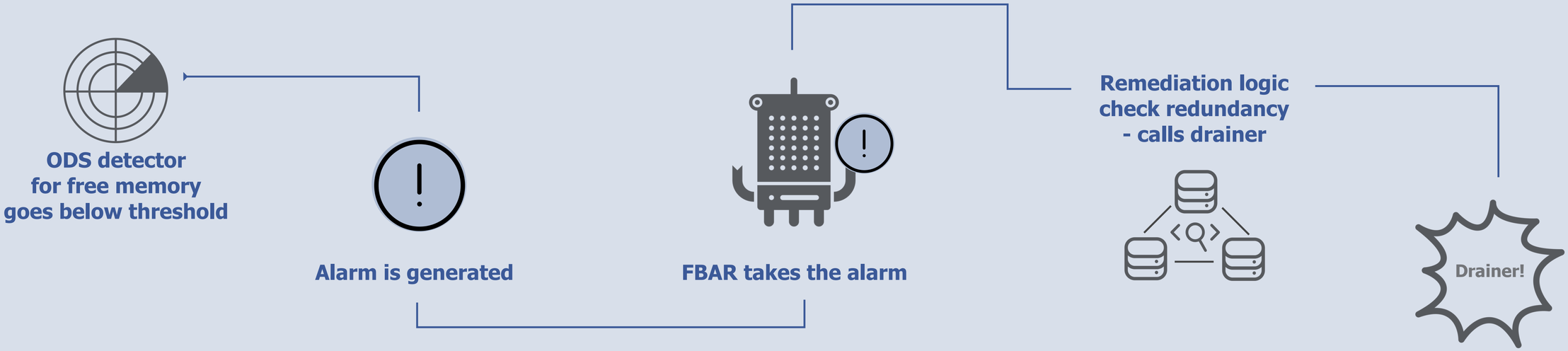
© 2015 Facebook | Dublin | Credits: radar by Harold Weaver https://thenounproject.com/term/radar/66335/, robot by Alexander Wiefel https://thenounproject.com/term/robot/65512/, explosion icon created by inconsmind.com https://thenounproject.com/term/explosion/70006,, server by Jevgeni Striganov https://thenounproject.com/term/server/57034/, check by useiconic.com https://thenounproject.com/term/server/57034/, loader by useiconic.com https://thenounproject.com/term/reload/45440/, code review by Arthur Shlain https://thenounproject.com/term/code-review/101170/, hands created by iconsmind.com for https://thenounproject.com/term/hands/67779/ https://creativecommons.org/licenses/by/3.0/

How is it now?



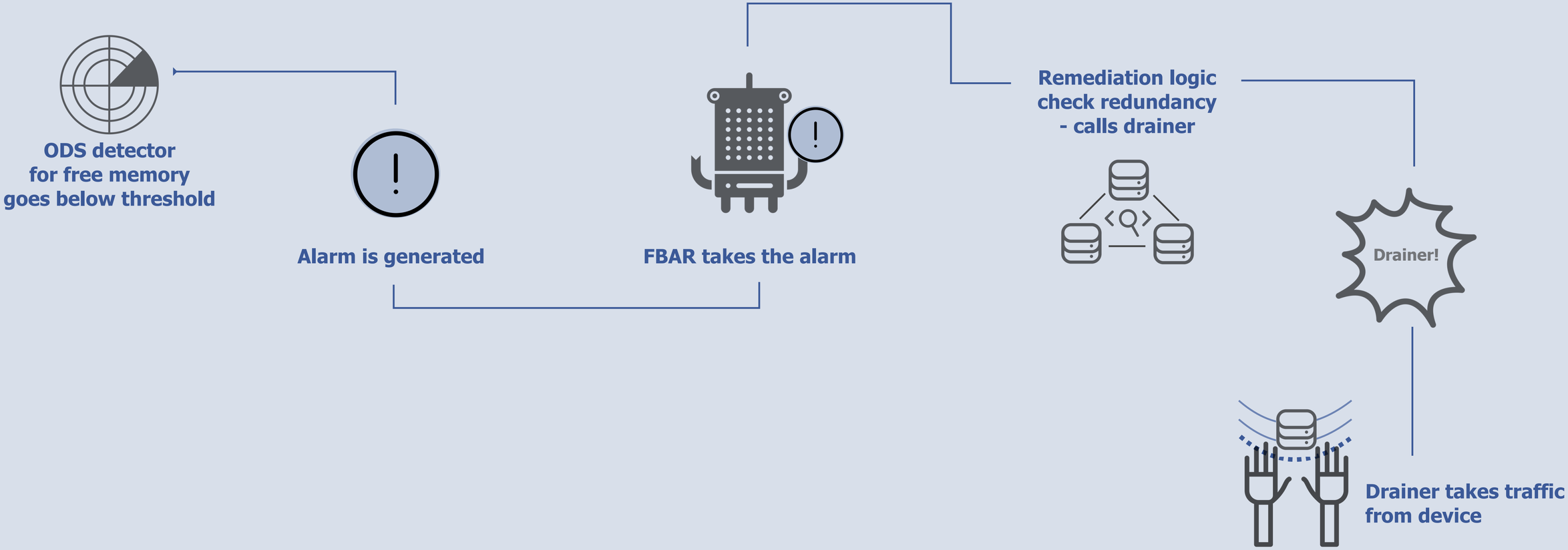
© 2015 Facebook | Dublin | Credits: radar by Harold Weaver https://thenounproject.com/term/radar/66335/, robot by Alexander Wiefel https://thenounproject.com/term/robot/65512/, explosion icon created by inconsmind.com https://thenounproject.com/term/explosion/70006,, server by Jevgeni Striganov https://thenounproject.com/term/server/57034/, check by useiconic.com https://thenounproject.com/term/server/57034/, loader by useiconic.com https://thenounproject.com/term/reload/45440/, code review by Arthur Shlain https://thenounproject.com/term/code-review/101170/, hands created by iconsmind.com for https://thenounproject.com/term/hands/67779/ https://creativecommons.org/licenses/by/3.0/

How is it now?



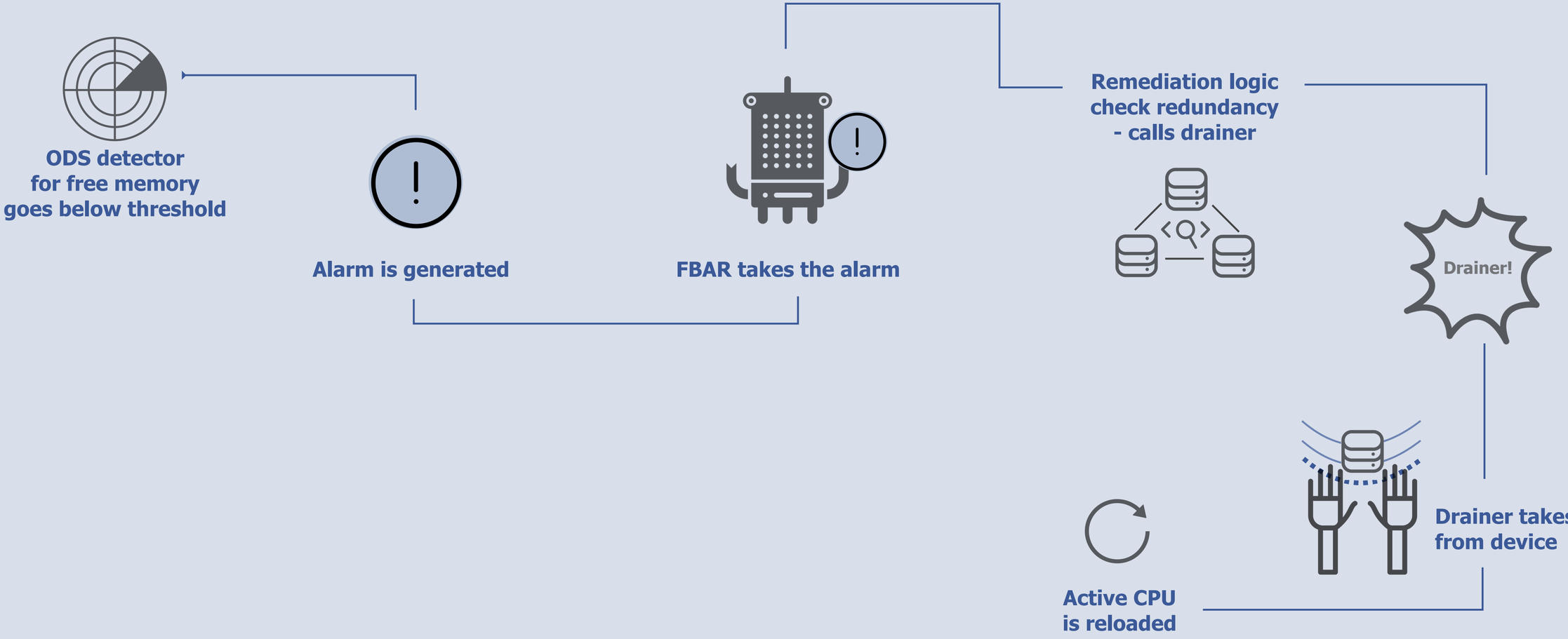
© 2015 Facebook | Dublin | Credits: radar by Harold Weaver https://thenounproject.com/term/radar/66335/, robot by Alexander Wiefel https://thenounproject.com/term/robot/65512/, explosion icon created by inconsmind.com https://thenounproject.com/term/explosion/70006,, server by Jevgeni Striganov https://thenounproject.com/term/server/57034/, check by useiconic.com https://thenounproject.com/term/server/57034/, loader by useiconic.com https://thenounproject.com/term/reload/45440/, code review by Arthur Shlain https://thenounproject.com/term/code-review/101170/, hands created by iconsmind.com for https://thenounproject.com/term/hands/67779/ https://creativecommons.org/licenses/by/3.0/

How is it now?



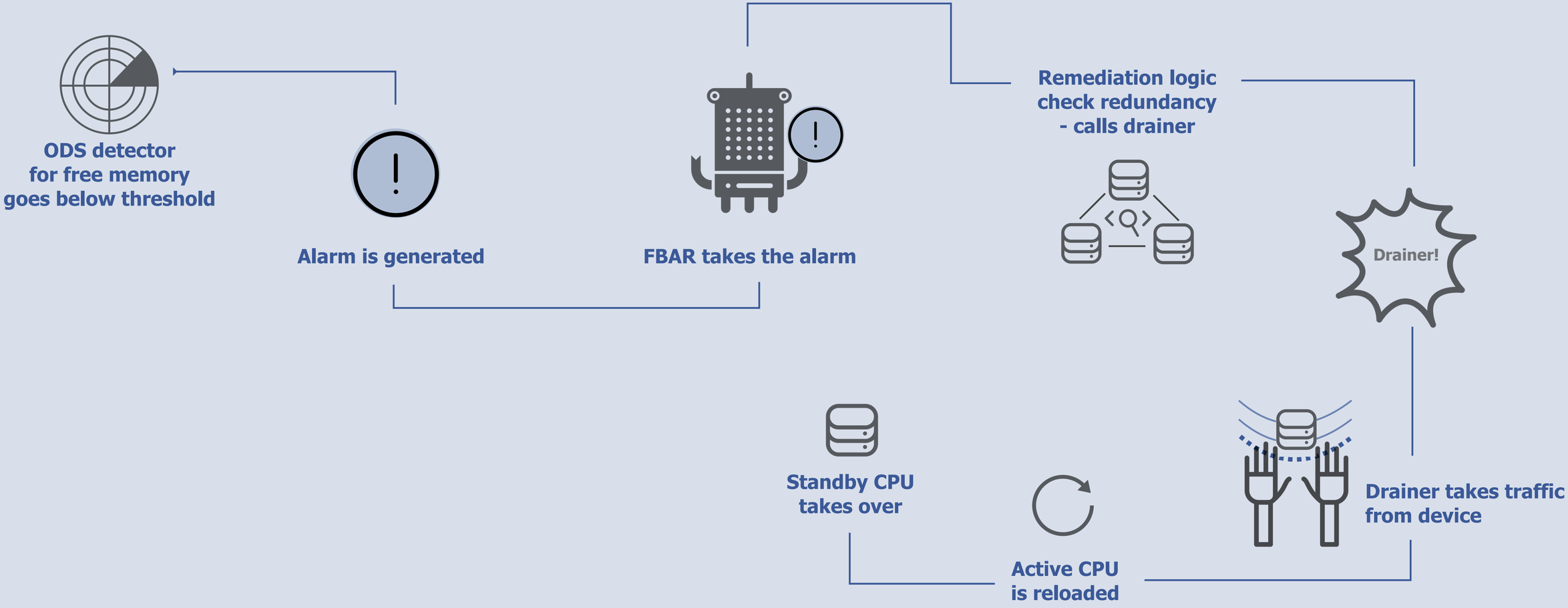
© 2015 Facebook | Dublin | Credits: radar by Harold Weaver https://thenounproject.com/term/radar/66335/, robot by Alexander Wiefel https://thenounproject.com/term/robot/65512/, explosion icon created by inconsmind.com https://thenounproject.com/term/explosion/70006,, server by Jevgeni Striganov https://thenounproject.com/term/server/57034/, check by useiconic.com https://thenounproject.com/term/server/57034/, loader by useiconic.com https://thenounproject.com/term/reload/45440/, code review by Arthur Shlain https://thenounproject.com/term/code-review/101170/, hands created by iconsmind.com for https://thenounproject.com/term/hands/67779/ https://creativecommons.org/licenses/by/3.0/

How is it now?



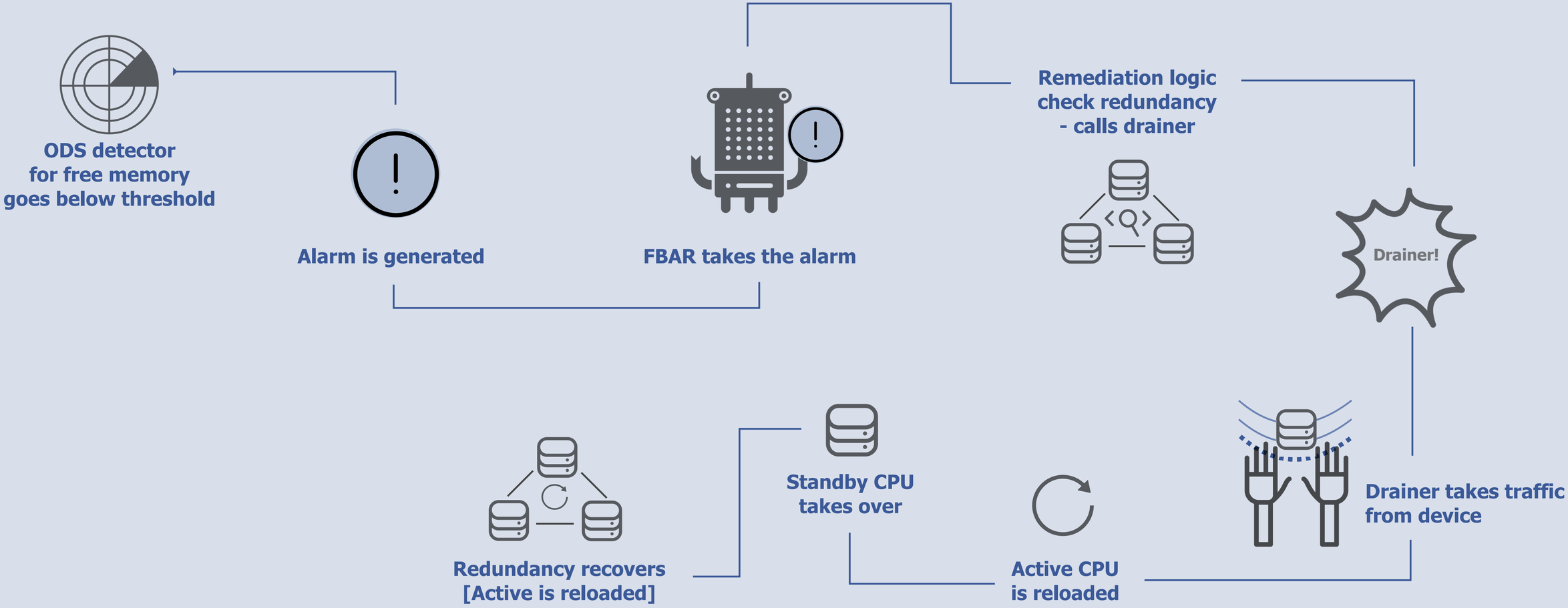
© 2015 Facebook | Dublin | Credits: radar by Harold Weaver https://thenounproject.com/term/radar/66335/, robot by Alexander Wiefel https://thenounproject.com/term/robot/65512/, explosion icon created by inconsmind.com https://thenounproject.com/term/explosion/70006,, server by Jevgeni Striganov https://thenounproject.com/term/server/57034/, check by useiconic.com https://thenounproject.com/term/server/57034/, loader by useiconic.com https://thenounproject.com/term/reload/45440/, code review by Arthur Shlain https://thenounproject.com/term/code-review/101170/, hands created by iconsmind.com for https://thenounproject.com/term/hands/67779/ https://creativecommons.org/licenses/by/3.0/

How is it now?



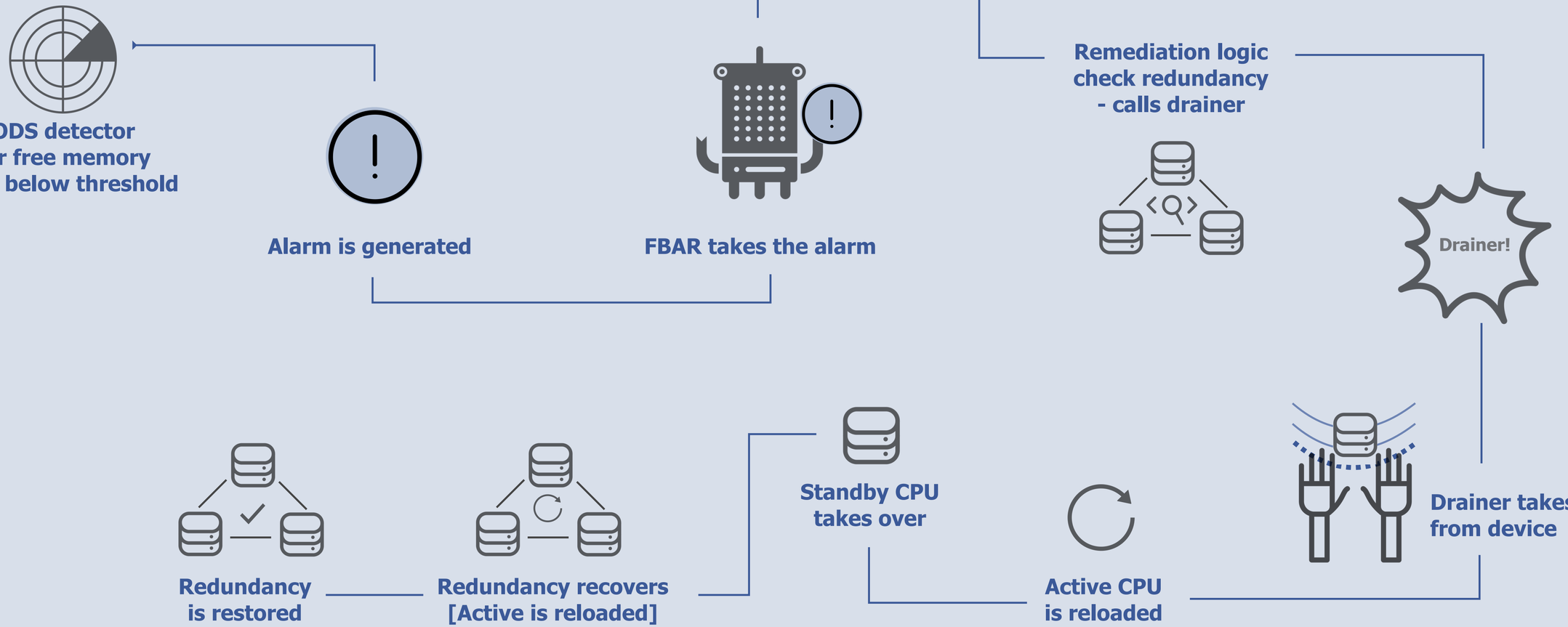
© 2015 Facebook | Dublin | Credits: radar by Harold Weaver https://thenounproject.com/term/radar/66335/, robot by Alexander Wiefel https://thenounproject.com/term/robot/65512/, explosion icon created by inconsmind.com https://thenounproject.com/term/explosion/70006,, server by Jevgeni Striganov https://thenounproject.com/term/server/57034/, check by useiconic.com https://thenounproject.com/term/server/57034/, loader by useiconic.com https://thenounproject.com/term/reload/45440/, code review by Arthur Shlain https://thenounproject.com/term/code-review/101170/, hands created by iconsmind.com for https://thenounproject.com/term/hands/67779/ https://creativecommons.org/licenses/by/3.0/

How is it now?



© 2015 Facebook | Dublin | Credits: radar by Harold Weaver https://thenounproject.com/term/radar/66335/, robot by Alexander Wiefel https://thenounproject.com/term/robot/65512/, explosion icon created by inconsmind.com https://thenounproject.com/term/explosion/70006,, server by Jevgeni Striganov https://thenounproject.com/term/server/57034/, check by useiconic.com https://thenounproject.com/term/server/57034/, loader by useiconic.com https://thenounproject.com/term/reload/45440/, code review by Arthur Shlain https://thenounproject.com/term/code-review/101170/, hands created by iconsmind.com for https://thenounproject.com/term/hands/67779/ https://creativecommons.org/licenses/by/3.0/

How is it now?

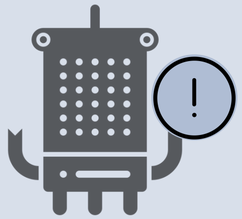


© 2015 Facebook | Dublin | Credits: radar by Harold Weaver https://thenounproject.com/term/radar/66335/, robot by Alexander Wiefel https://thenounproject.com/term/robot/65512/, explosion icon created by inconsmind.com https://thenounproject.com/term/explosion/70006,, server by Jevgeni Striganov https://thenounproject.com/term/server/57034/, check by useiconic.com https://thenounproject.com/term/server/57034/, loader by useiconic.com https://thenounproject.com/term/reload/45440/, code review by Arthur Shlain https://thenounproject.com/term/code-review/101170/, hands created by iconsmind.com for https://thenounproject.com/term/hands/67779/ https://creativecommons.org/licenses/by/3.0/

How is it now?

ODS detector
for free memory
goes below threshold

Alarm is generated

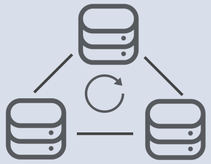


FBAR takes the alarm

Remediation logic
check redundancy
- calls drainer

Device undrained

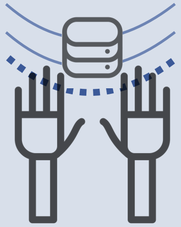
Redundancy
is restored



Redundancy recovers
[Active is reloaded]

Standby CPU
takes over

Active CPU
is reloaded

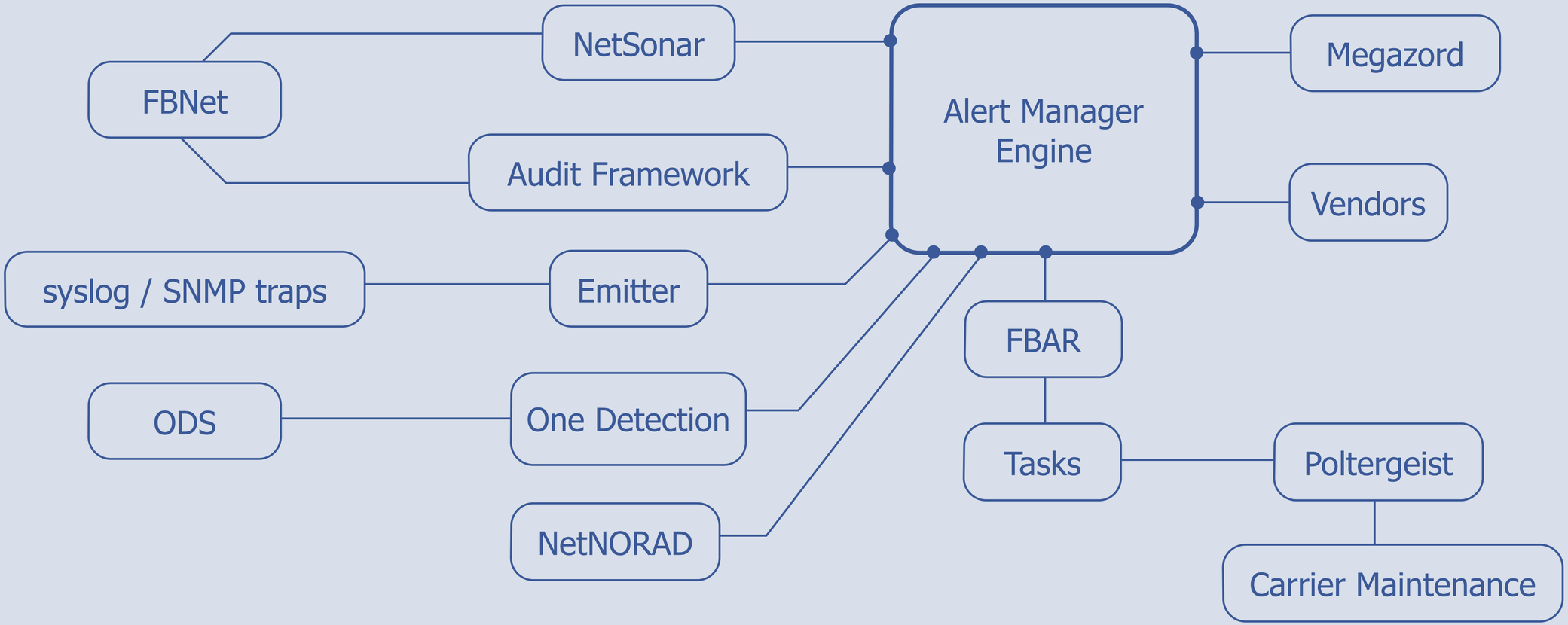


Drainer takes traffic
from device

© 2015 Facebook | Dublin | Credits: radar by Harold Weaver https://thenounproject.com/term/radar/66335/, robot by Alexander Wiefel https://thenounproject.com/term/robot/65512/, explosion icon created by inconsmind.com https://thenounproject.com/term/explosion/70006,, server by Jevgeni Striganov https://thenounproject.com/term/server/57034/, check by useiconic.com https://thenounproject.com/term/server/57034/, loader by useiconic.com https://thenounproject.com/term/reload/45440/, code review by Arthur Shlain https://thenounproject.com/term/code-review/101170/, hands created by iconsmind.com for https://thenounproject.com/term/hands/67779/ https://creativecommons.org/licenses/by/3.0/

Facebook Defined Networking

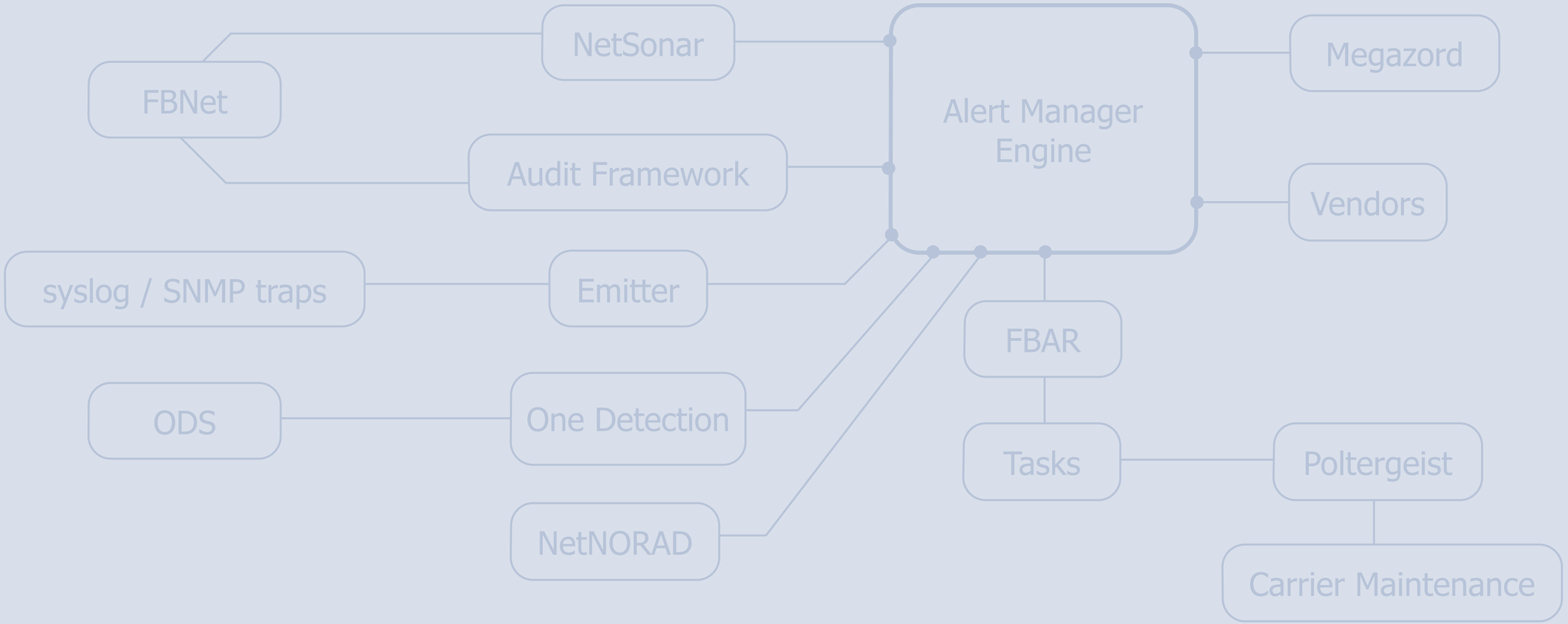
all components in action



© 2015 Facebook | Dublin

So, in 30 days...

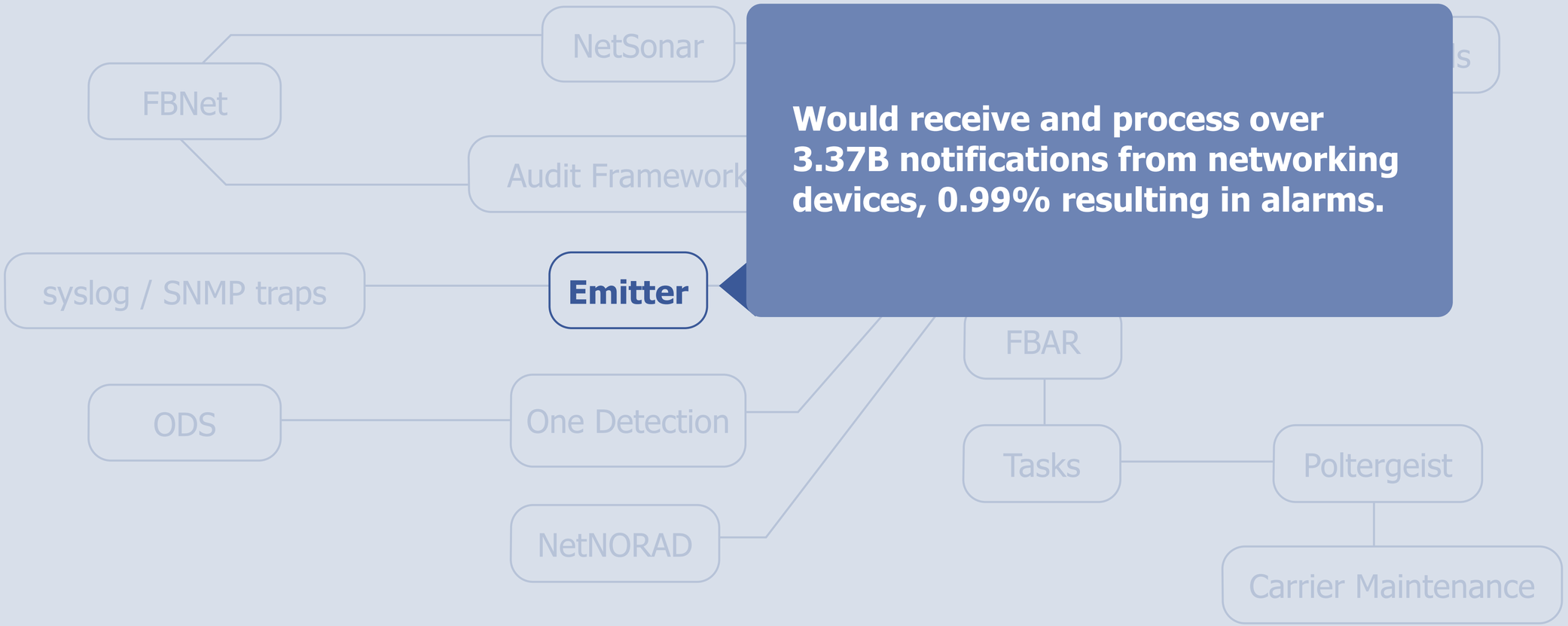
all components in action



© 2015 Facebook | Dublin

So, in 30 days...

all components in action



© 2015 Facebook | Dublin

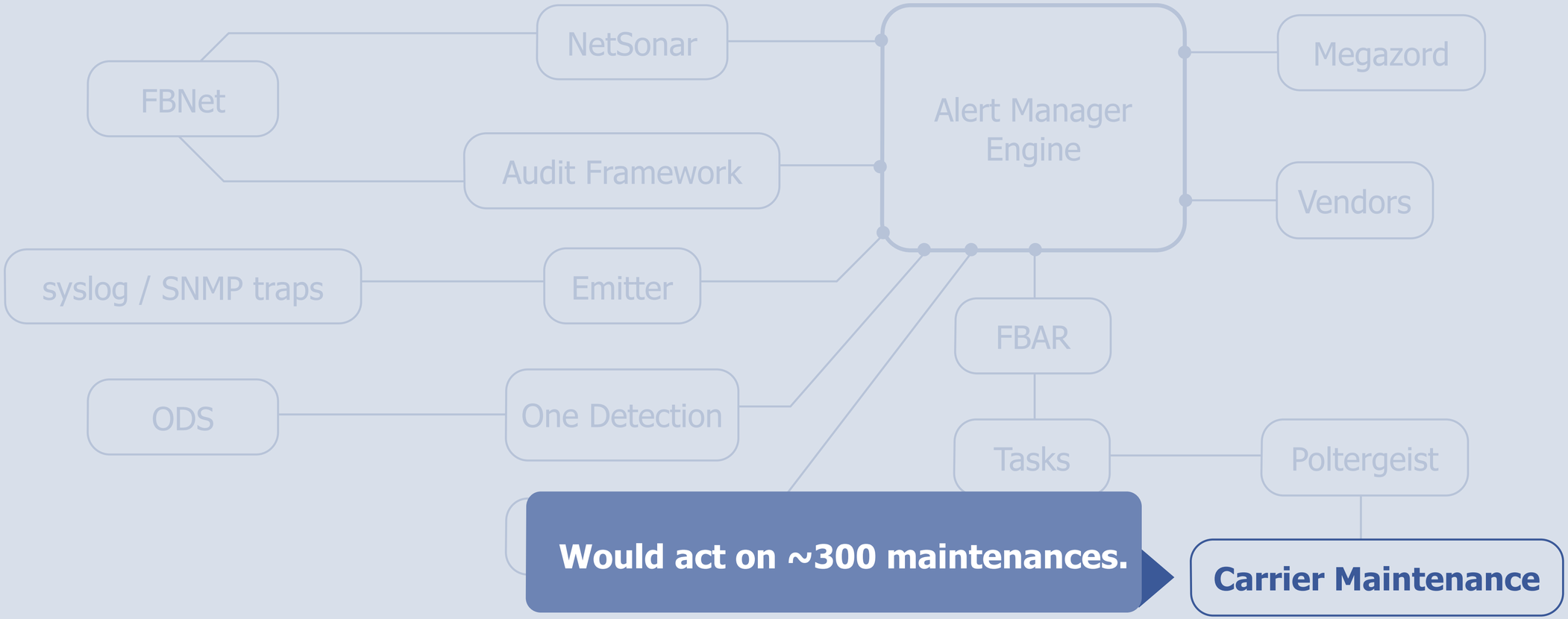
So, in 30 days...

all components in action

© 2015 Facebook | Dublin

So, in 30 days...

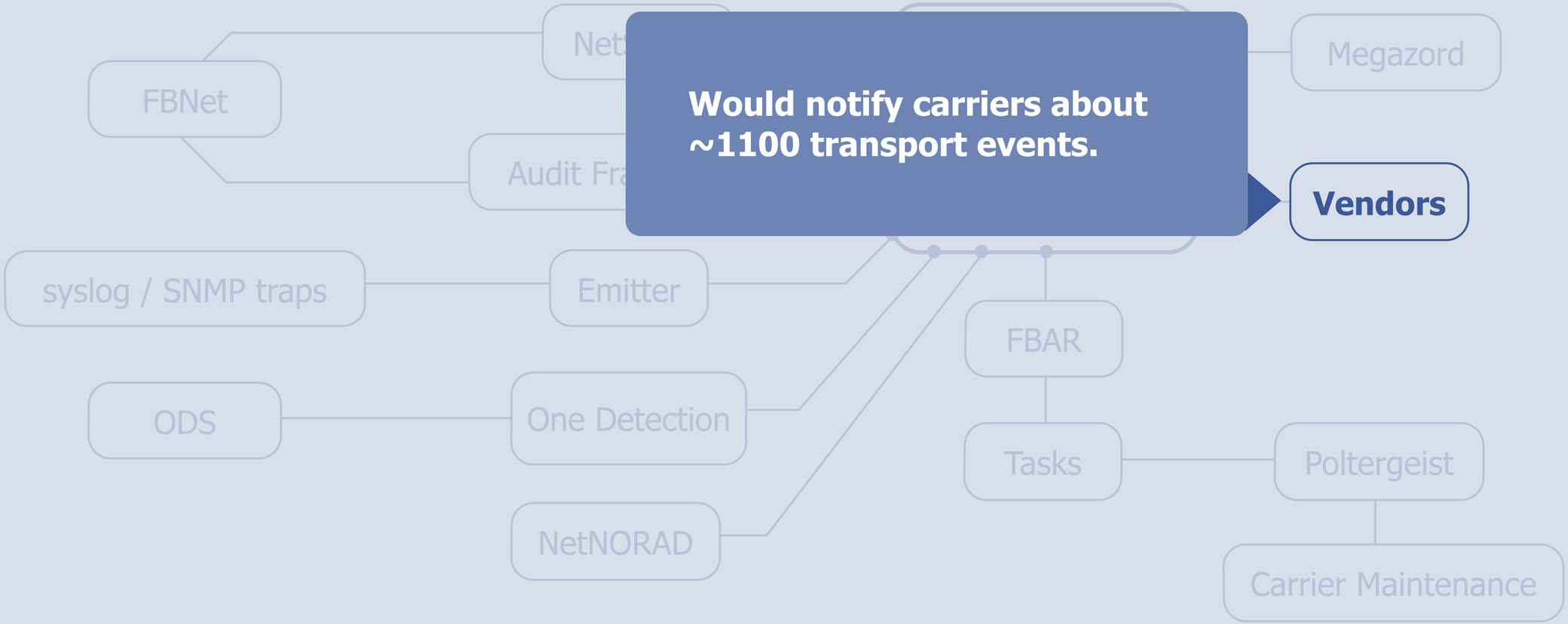
all components in action



© 2015 Facebook | Dublin

So, in 30 days...

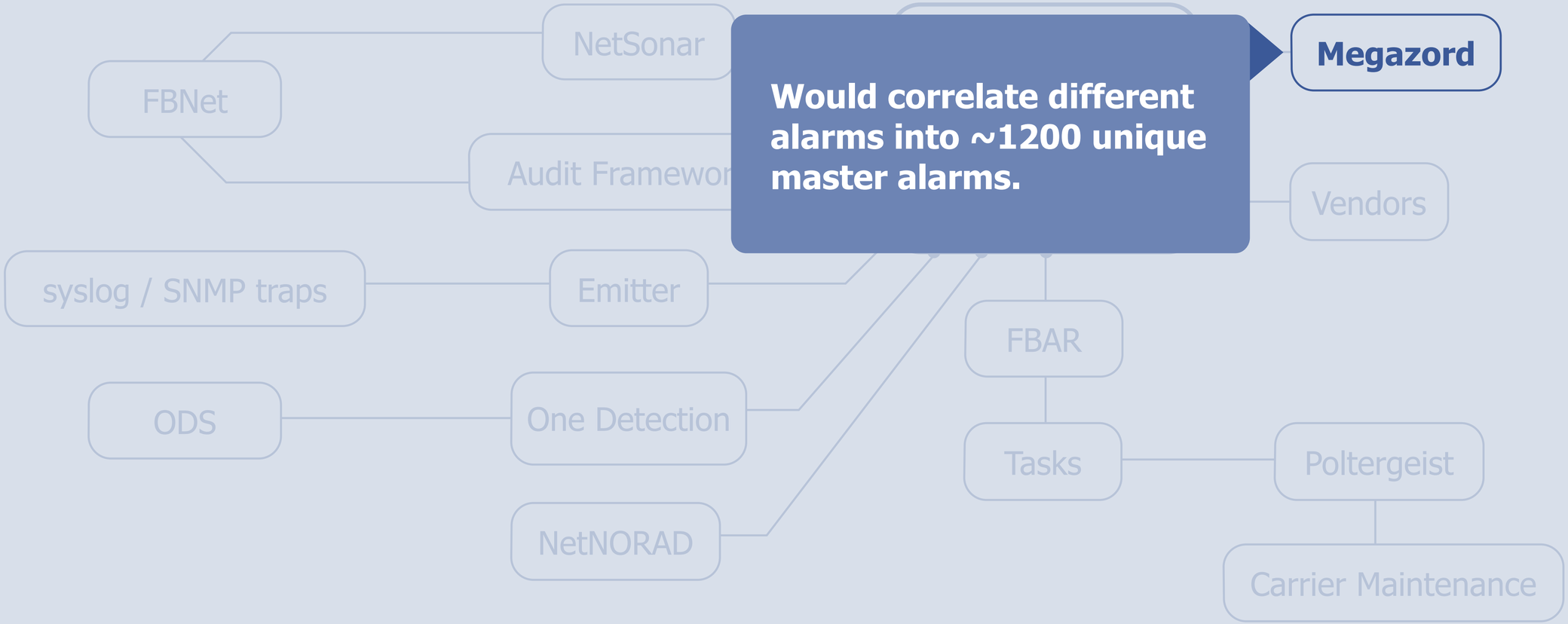
all components in action



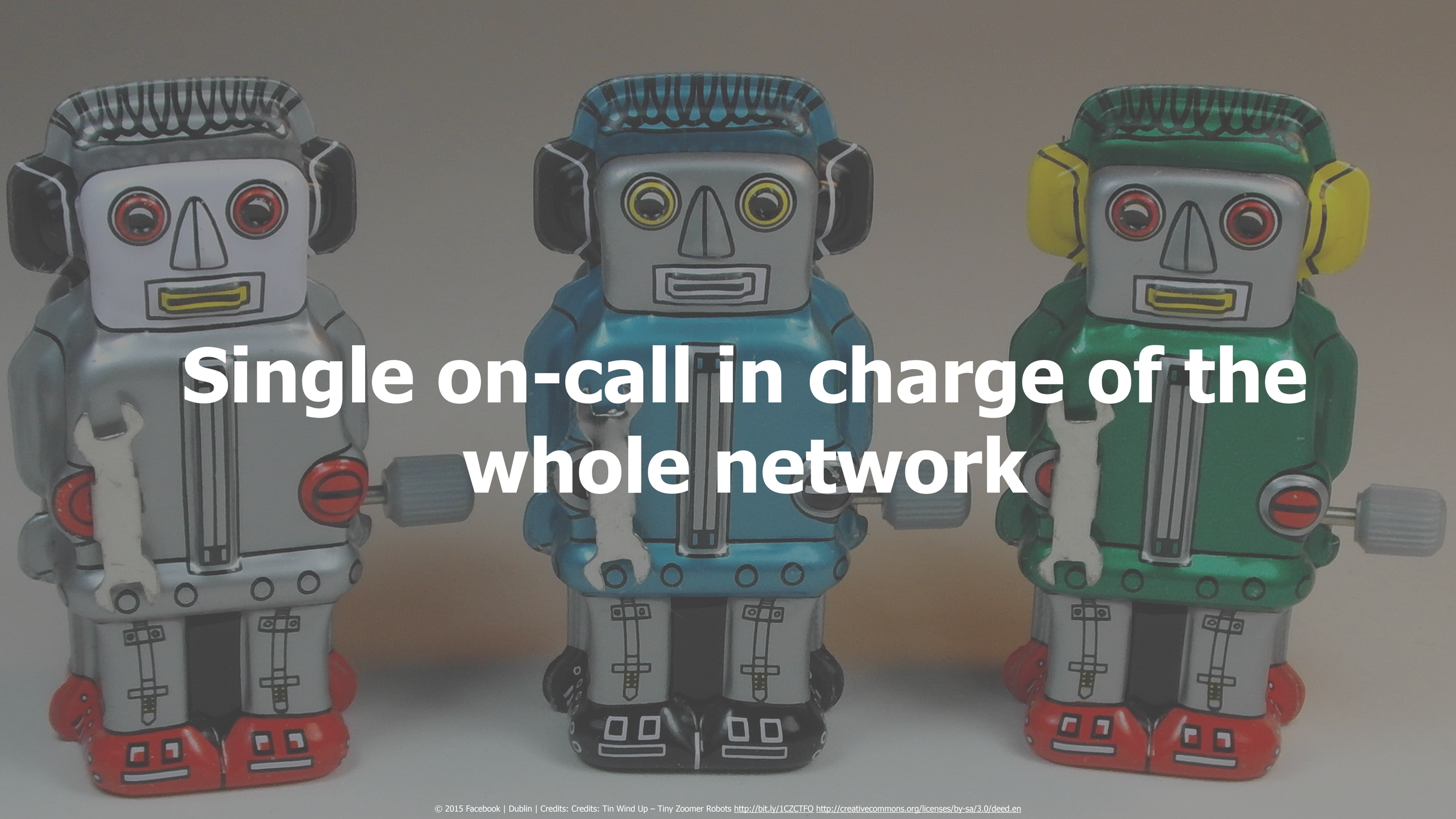
© 2015 Facebook | Dublin

So, in 30 days...

all components in action



© 2015 Facebook | Dublin

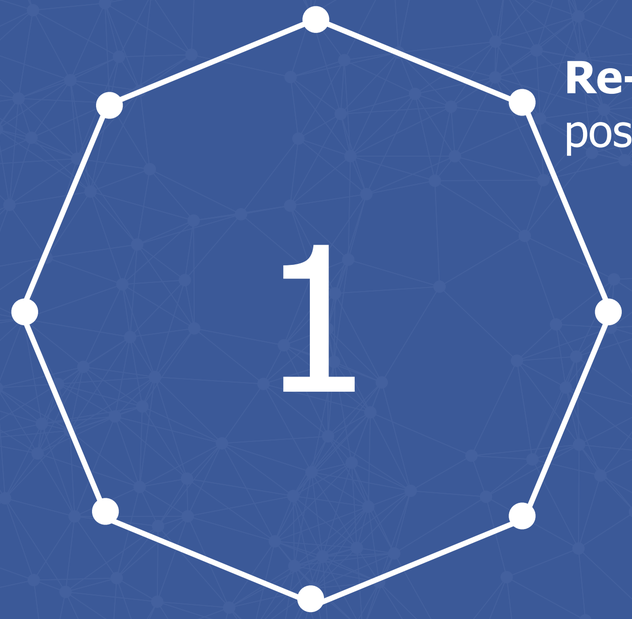


© 2015 Facebook | Dublin | Credits: Credits: Tin Wind Up – Tiny Zoomer Robots http://bit.ly/1CZCTFO http://creativecommons.org/licenses/by-sa/3.0/deed.en

Lessons Learned & Recommendations

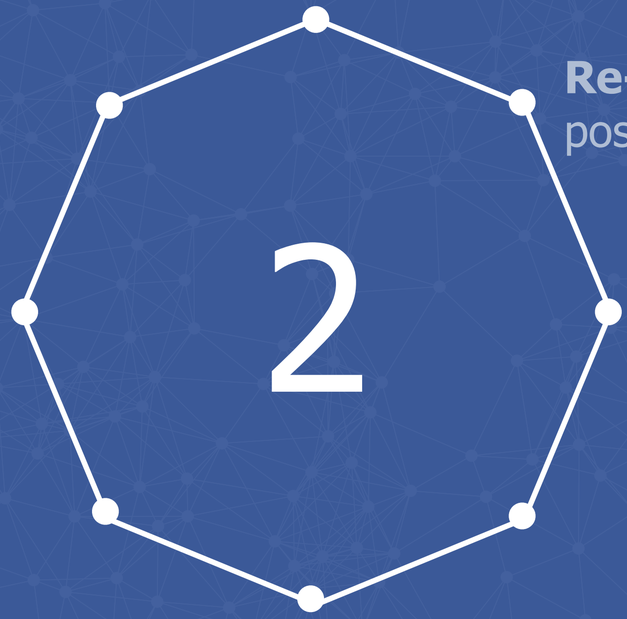
© 2015 Facebook | Dublin | Credits: Photo by Jose Leitao https://creativecommons.org/licenses/by/3.0/

8 Lessons Learned & Recommendations



Re-use existing code/tools when possible and when it makes sense.

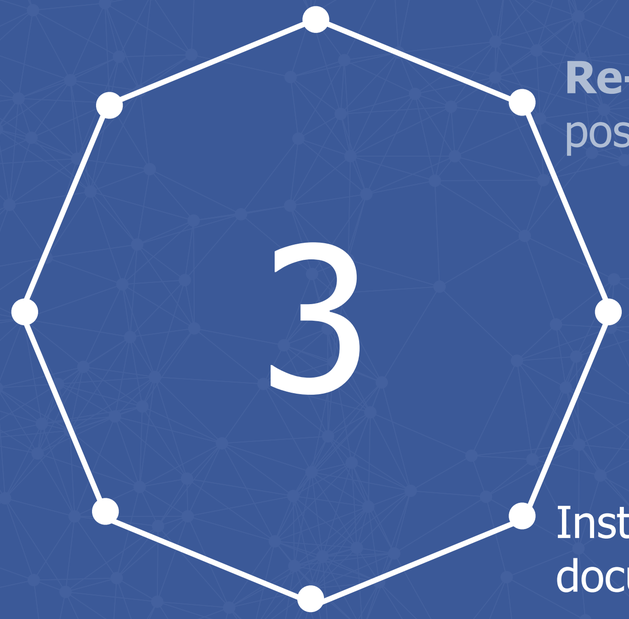
8 Lessons Learned & Recommendations



Re-use existing code/tools when possible and when it makes sense.

Hacks quickly become **important tools.**

8 Lessons Learned & Recommendations

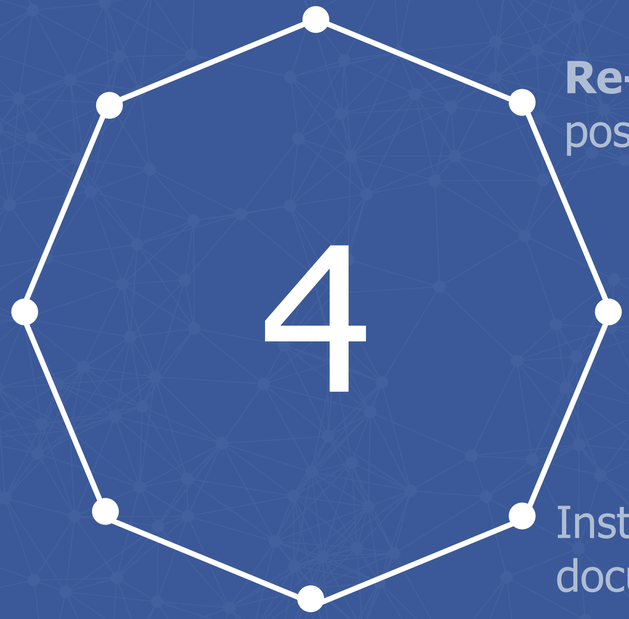


Re-use existing code/tools when possible and when it makes sense.

Hacks quickly become **important tools.**

Instrument / unit-test / document **all the things.**

8 Lessons Learned & Recommendations



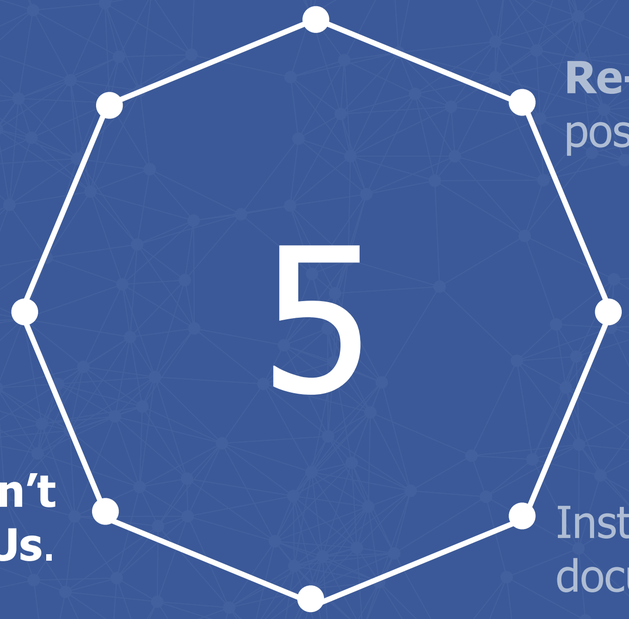
Re-use existing code/tools when possible and when it makes sense.

Hacks quickly become **important tools.**

Instrument / unit-test / document **all the things.**

Poke for feedback often: if users don’t like the tool, they won’t use it.

8 Lessons Learned & Recommendations



Re-use existing code/tools when possible and when it makes sense.

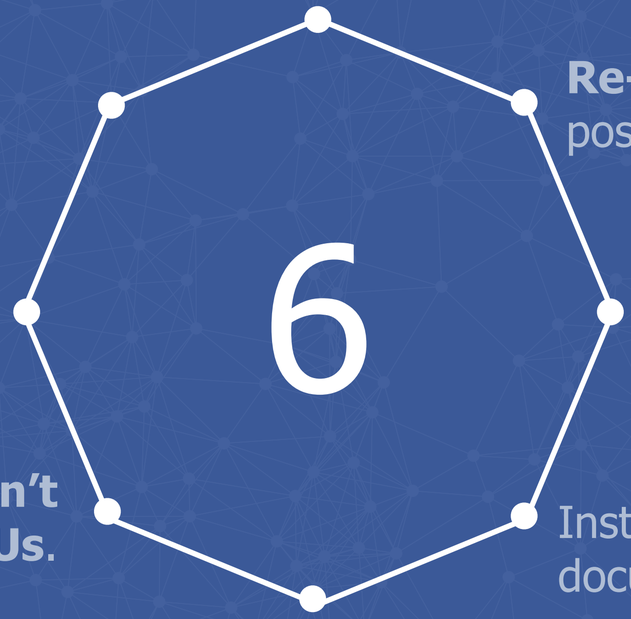
Hacks quickly become **important tools.**

Instrument / unit-test / document **all the things.**

Poke for feedback often: if users don’t like the tool, they won’t use it.

Networking devices **don’t have powerful CPUs**.

8 Lessons Learned & Recommendations



Re-use existing code/tools when possible and when it makes sense.

Hacks quickly become **important tools.**

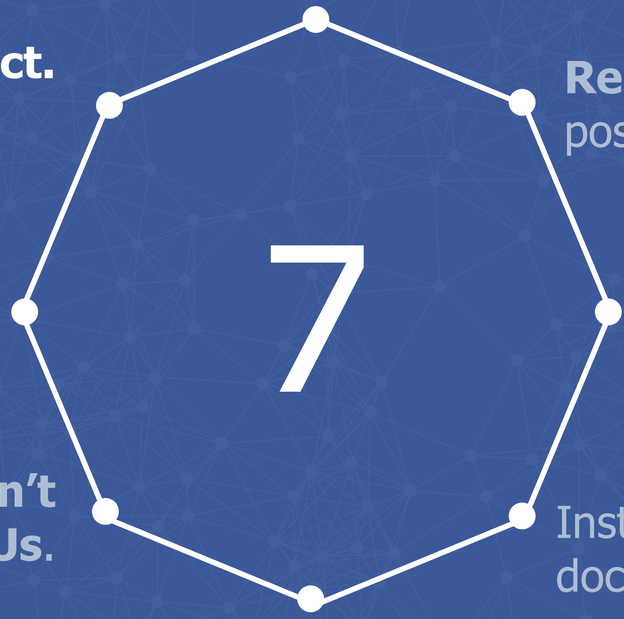
Instrument / unit-test / document **all the things.**

Poke for feedback often: if users don't like the tool, they won't use it.

Networking devices **don't have powerful CPUs**.

The sooner the robots take over, the better.

8 Lessons Learned & Recommendations



Talk is cheap, **focus on impact.**

Re-use existing code/tools when possible and when it makes sense.

The sooner the robots take over, the better.

Hacks quickly become **important tools.**

Networking devices **don’t have powerful CPUs**.

Instrument / unit-test / document **all the things.**

Poke for feedback often: if users don’t like the tool, they won’t use it.

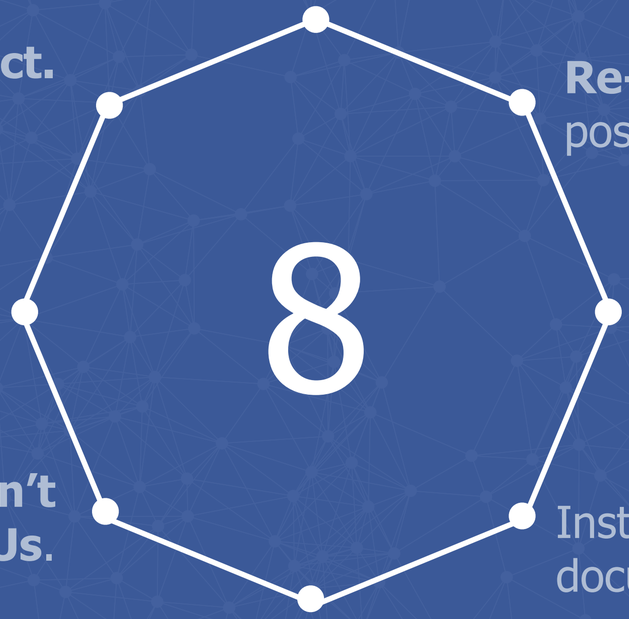
8 Lessons Learned & Recommendations

Done is better than perfect!

Talk is cheap, **focus on impact.**

Re-use existing code/tools when possible and when it makes sense.

The sooner the robots take over, the better.



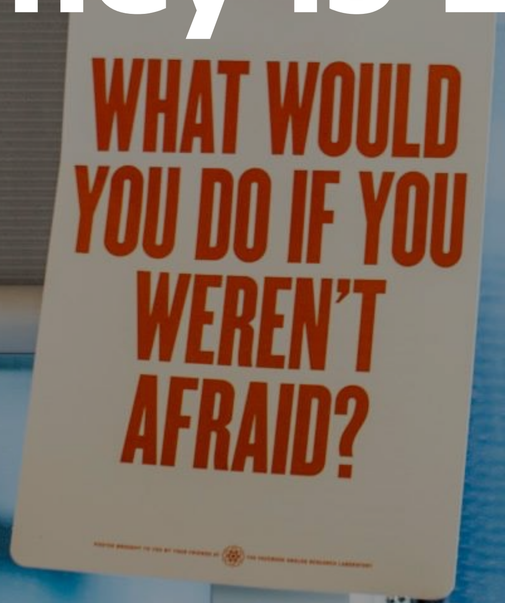
Hacks quickly become **important tools.**

Networking devices **don’t have powerful CPUs**.

Instrument / unit-test / document **all the things.**

Poke for feedback often: if users don’t like the tool, they won’t use it.

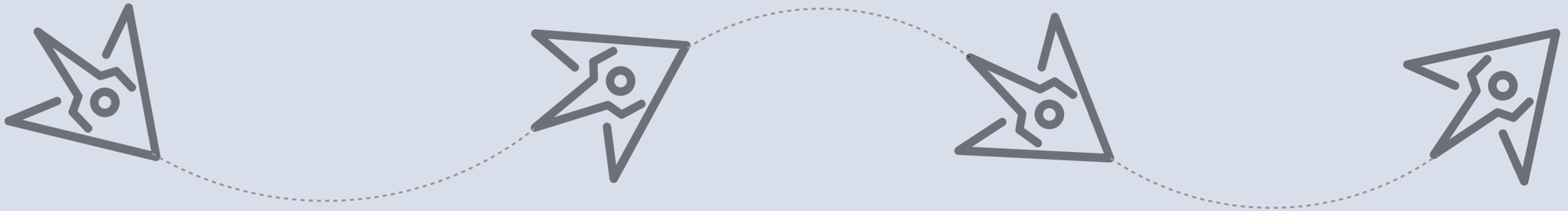
This journey is 1% finished



© 2015 Facebook | Dublin | Credits: Photo by Jose Leitao https://creativecommons.org/licenses/by/3.0/

What's in the near future?

The journey is 1% finished



FBOSS / Wedge / sixpack operationalization improvements

Better visibility in the WDM space and correlation between the Optical / IP worlds

PCE

Continuous development of existing tools

© 2015 Facebook | Dublin | Credits: Paraglider icon by Matt Brooks https://thenounproject.com/term/paraglider/114410/ https://creativecommons.org/licenses/by/3.0/

© 2015 Facebook | Dublin | Credits: Say Thanks - Various Artists - https://www.facebook.com/stickers/1407088142851607/

WHAT WOULD YOU DO IF YOU WEREN'T AFRAID?

POSTER BROUGHT TO YOU BY YOUR FRIENDS AT THE FACEBOOK ANALOG RESEARCH LABORATORY

© 2015 Facebook | Dublin

© 2015 Facebook | Dublin | Credits: Photo by Jose Leitao https://creativecommons.org/licenses/by/3.0/