Network Complexity

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Cisco Systems

RIPE-61

16 Nov 2010, Rome, IT

Intuitively, Network Complexity is

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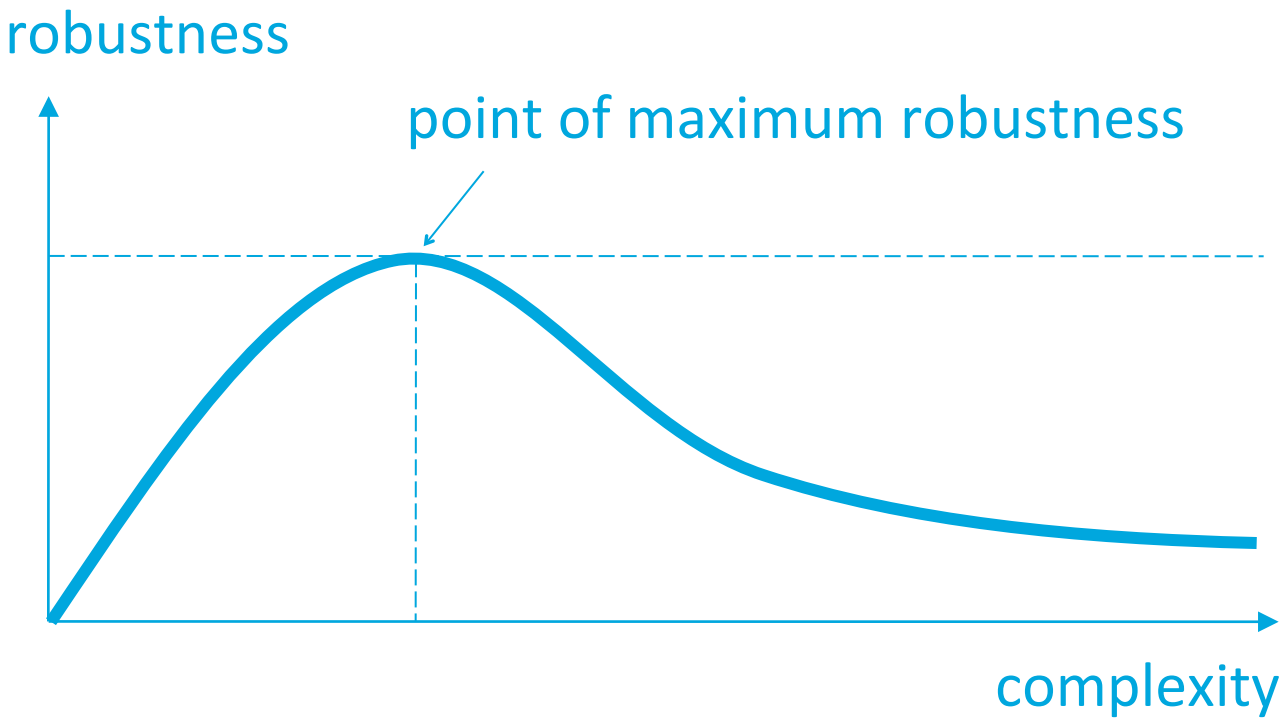
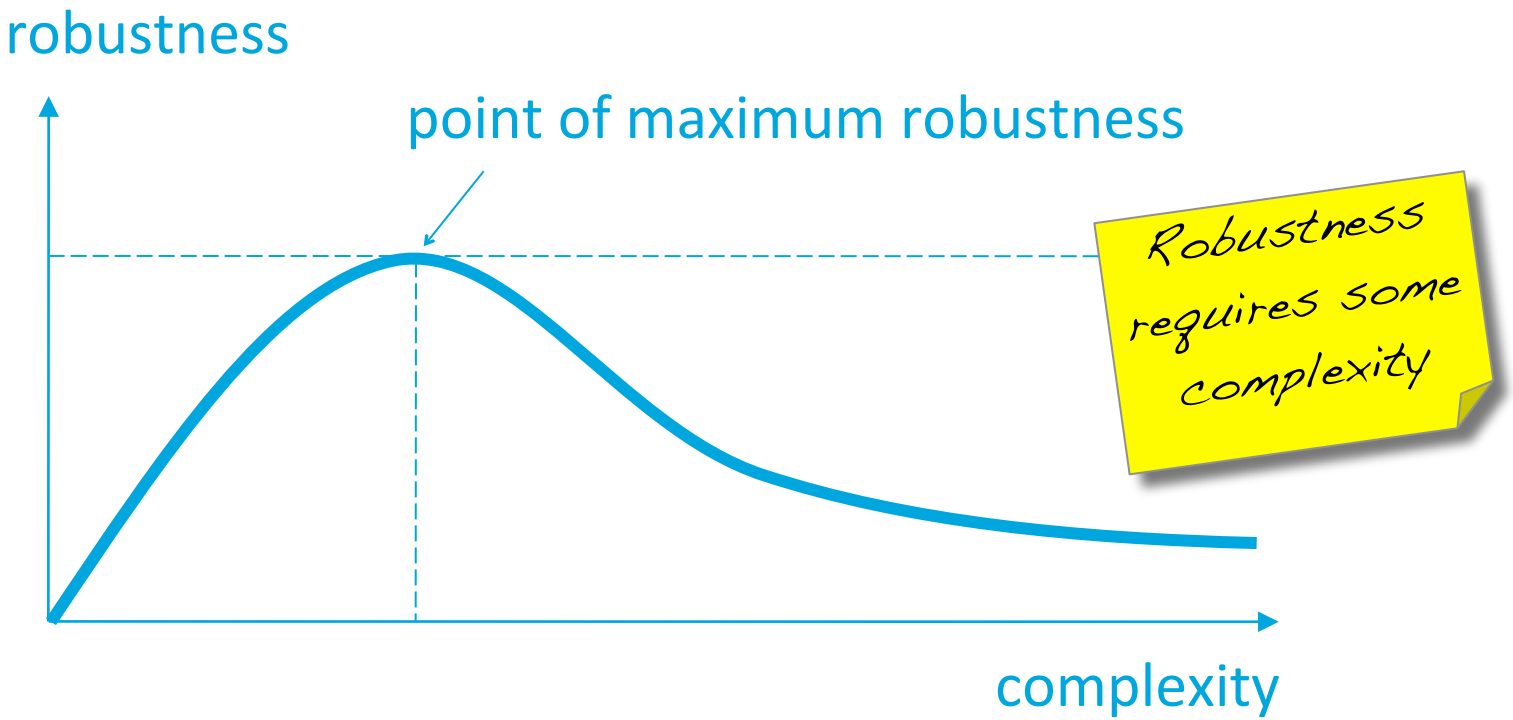
… but, what is "Network Complexity"?

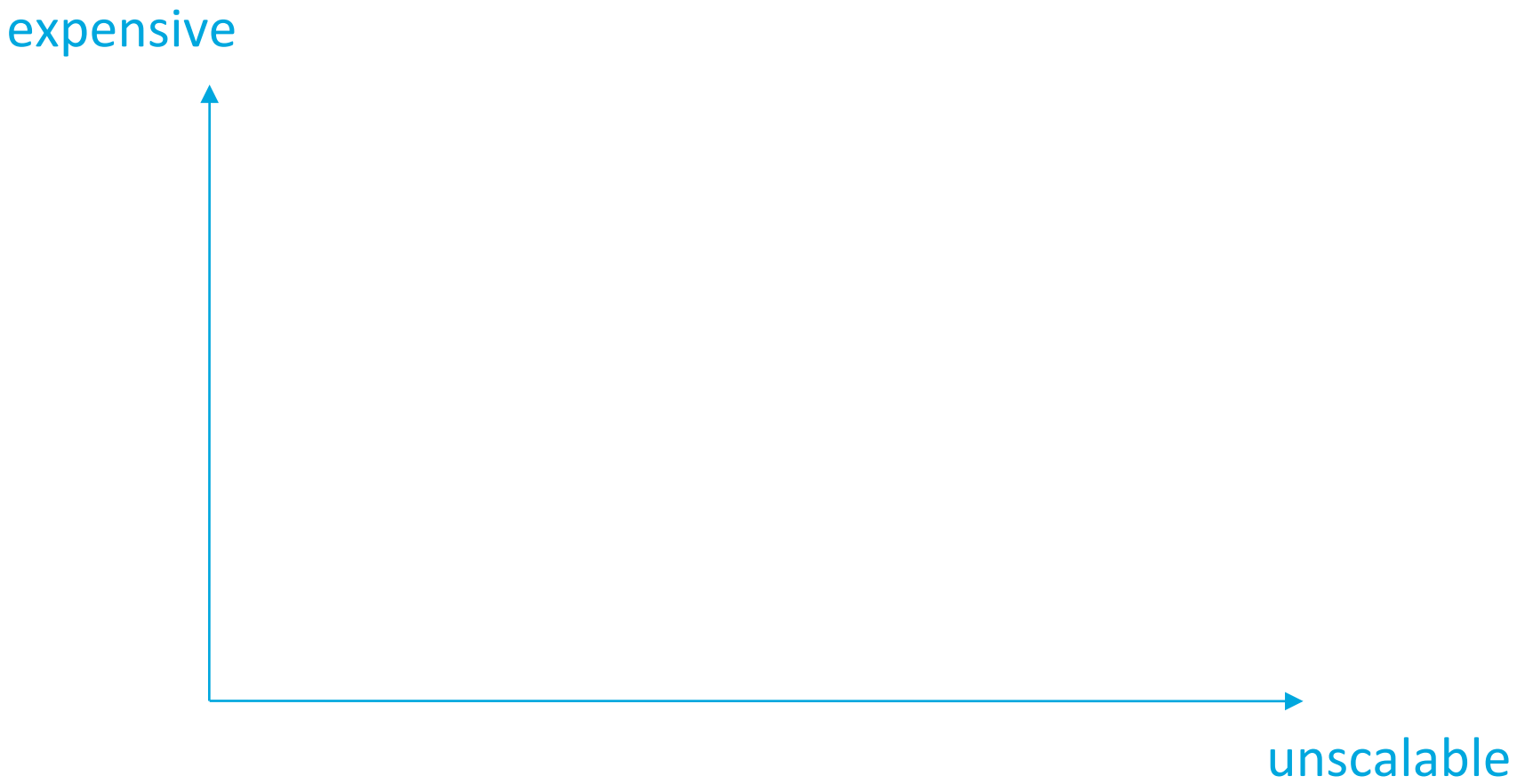
You Need Complexity (at least some)



You Need Complexity (at least some)

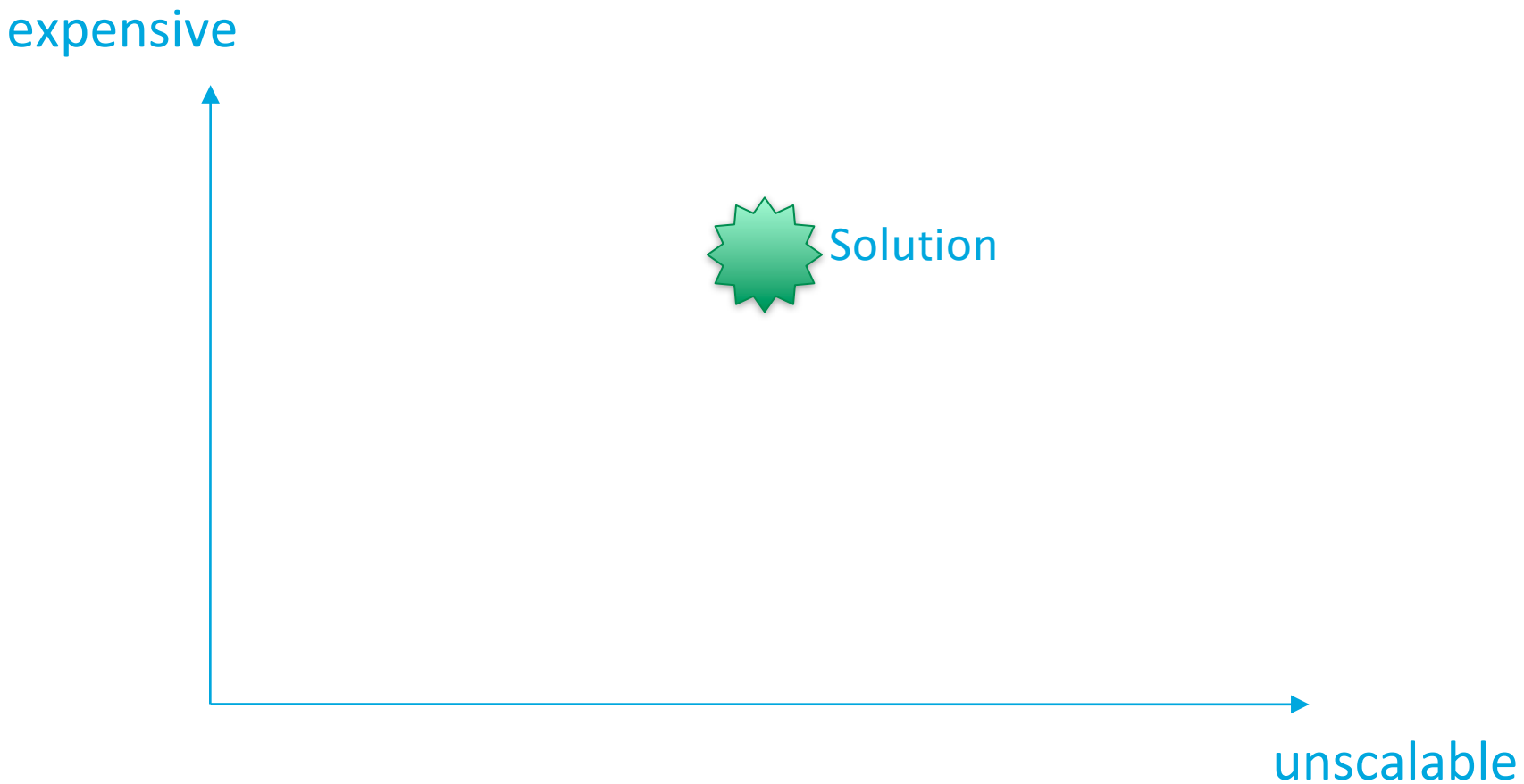


Tradeoffs and Complexity



Source: John Doyle

Tradeoffs and Complexity



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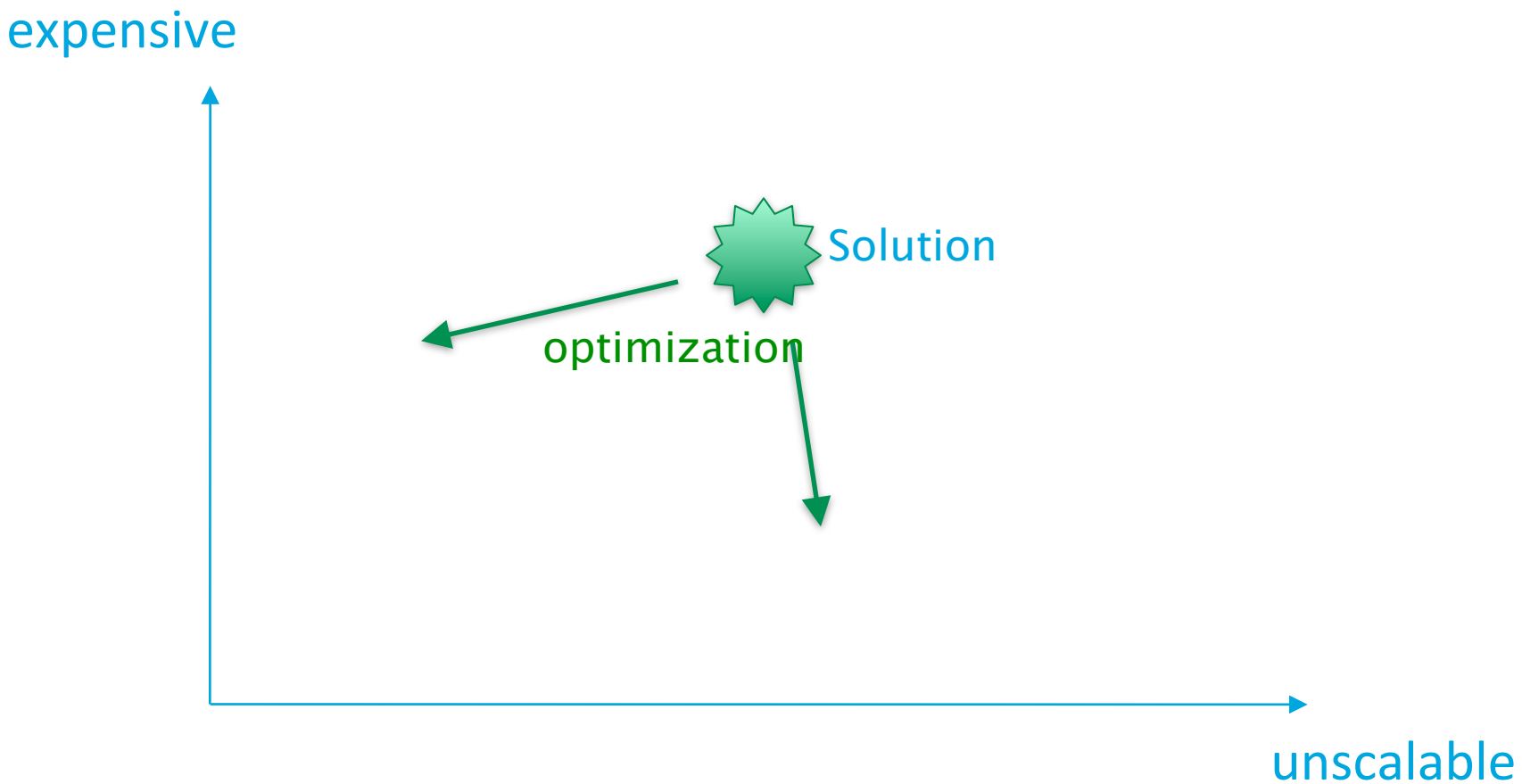

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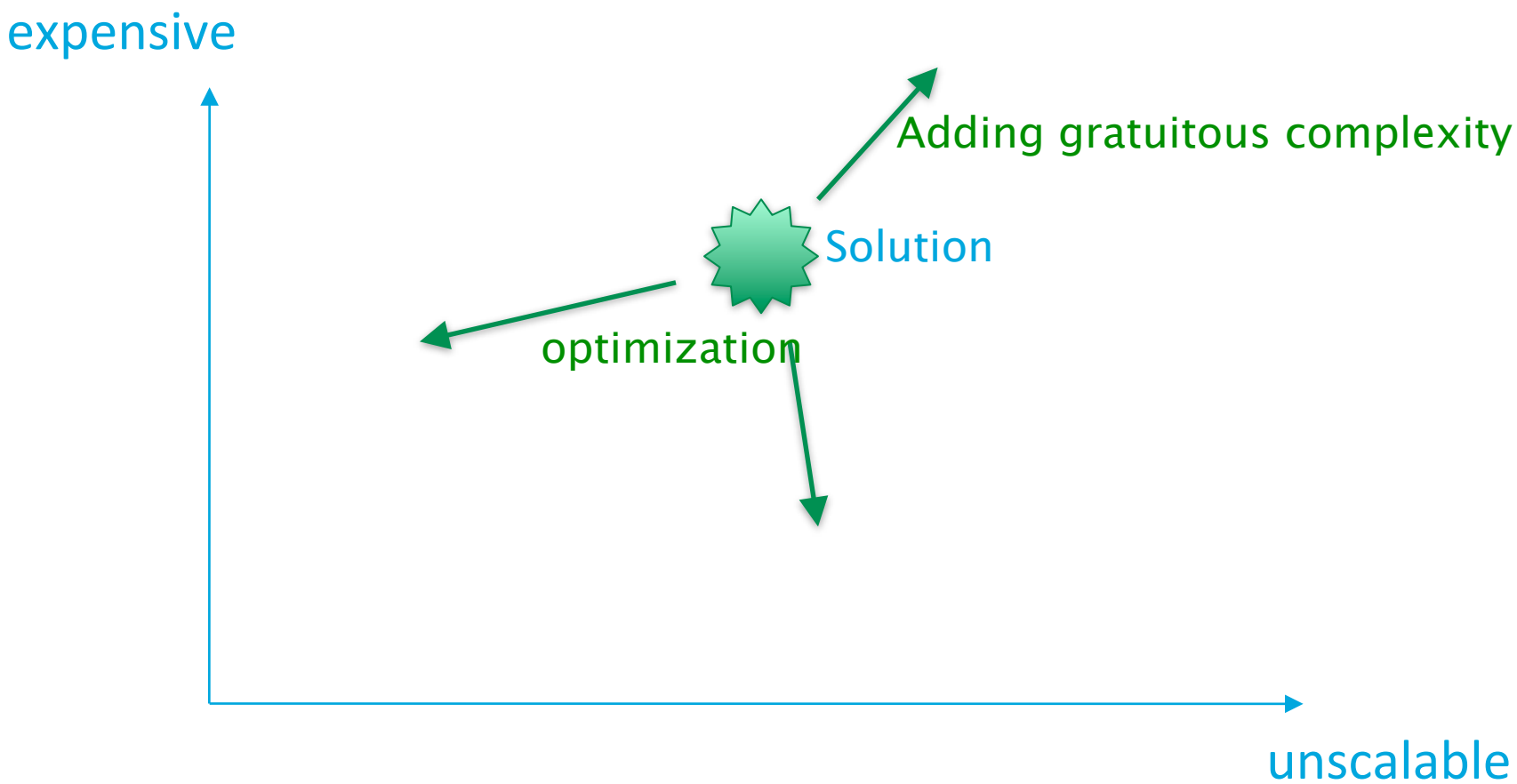

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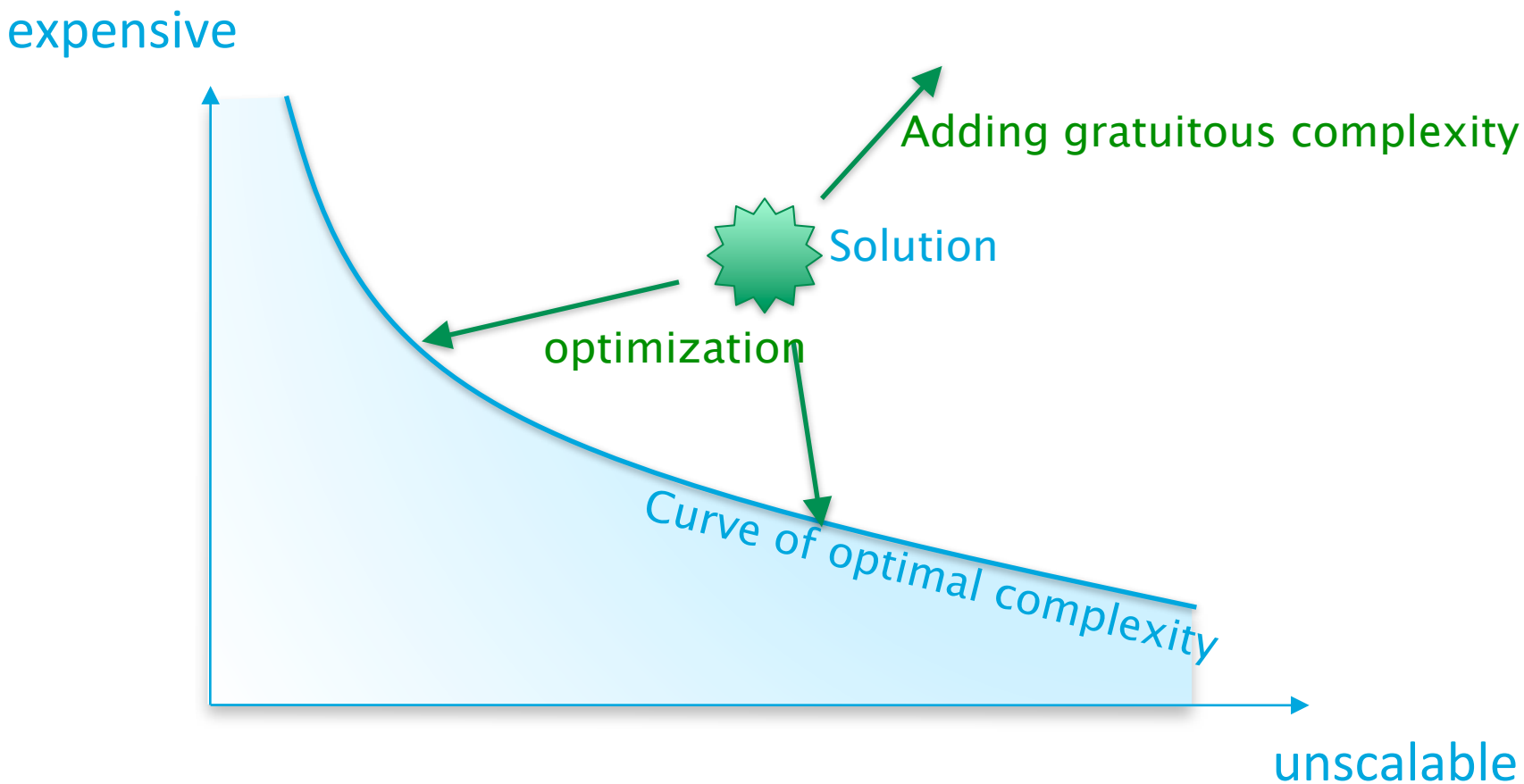

Source: John Doyle

Elements To Consider: “State”

Source: “Classifying Network Complexity; http://conferences.sigcomm.org/co-next/2009/workshops/rearch/

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physical network

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operator

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network
management

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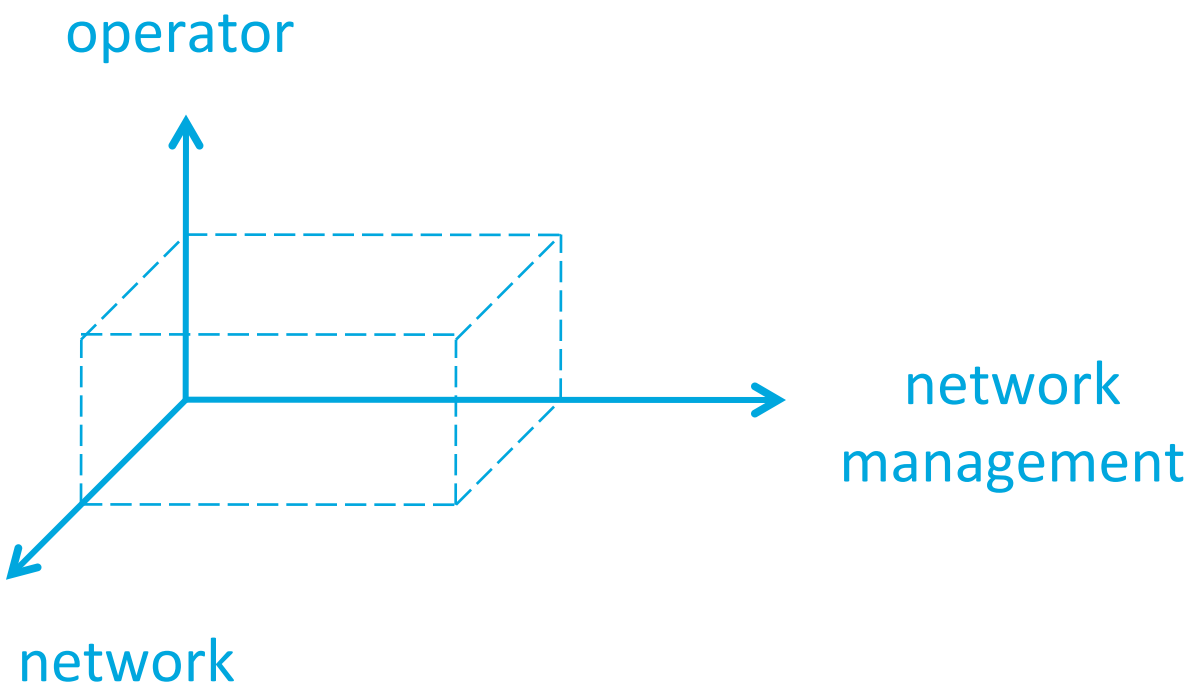

The “Complexity Cube”

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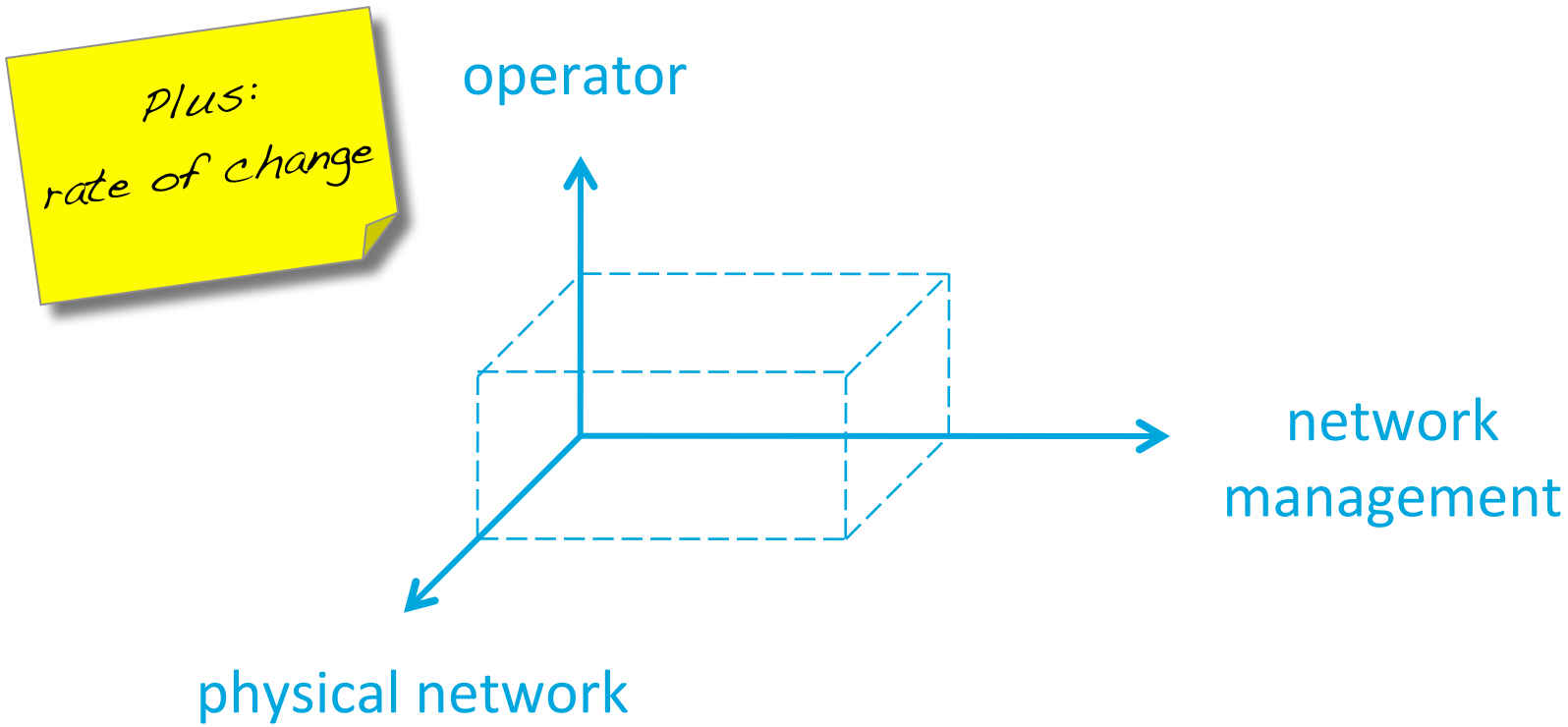

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Survey on Network Complexity

- Link sent to RIPE-list on 9 Nov 2010
- 64 Responses
- Profile of people who filled in the survey:

How many years experince do you have in network operation?		
Answer Options	Response Percent	Response Count
More than 10	76.6%	49
5-10	17.2%	11
Less than 5	1.6%	1
I'm not in operations	4.7%	3

Have you experienced “catastrophic

NO (2)

Source: Survey for RIPE-61, presented on 16 Nov 2010 in Rome (panel on network complexity)

If yes, what was the cause of this catastrophic failure?

How likely do you think that over the next 5

Answer Options	Response Percent	Response Count
Pretty likely	20.3%	13
Possible	56.3%	36
Unlikely	23.4%	15

How often do you encounter network

31.3% (20)

56.3% (36)

12.5% (8)

Where is the origin of complexity in your network *mainly* located?

Other…

ESX running with different vendors, e.g HP c7000 and IBM BladeCenter H. All with HypervSphere(x) running, different network vendors like (BNT) BladeNetworks on IBM+Emulex+QLogic - Brocade, Cisco etc on HP c7000, linking up to e.g Nexus 50xx platform on 10Gbps. VM's and the infrastructure from host to end link, many components are involved and many different BIOS/ Firmware version on these. Any poor code in just one of these vendor components can result in a catastrophic failure up to the CORE. We have already expired this.

Lack of documentation, cable labelling etc

High volume of devices, Complex topology

The unnecessary grafts added by various complications departments without regard for architectural elegance and simplicity.

Router configurations, Human operator, design, boss requirement

Multiple conflicting customer requirements

Both physical cause, operator mistakes and buggy behaviour i router software.

A combination of the above as, for example, an "e2e" IP service requires 3 layers and a number of different technology hops.

Your Definitions of "Network Complexity"

The number of elements within a network and the associated loss of determinism in predicting network behaviour.
not easy to manage, not easily adaptable to changes
Hardness in documentating relations between physical equipment, logical entities and operating procedures.
From virtual host - towards the ISP at last. The complexity is from the VM's hardware link which now also is virtual configured - towards shared 10Gbps links in the hardware enclosure (sometimes up to 3 components) before it is linked to the distribution switch level and then the CORE. Cloud business is demanding more of this, which again makes it all more complex in the internal cloud infrastructure.
Patches applied on the infrastructure over time, out of initial architecture planning.
a network with too many configuration to do a basic thing.
Network complexity means that the network depends on so much interdependent factors that changes apparently safe end up affecting seriously the network operation.
Often we have to re-invent the wheel
Set of configurations, technologies and designs that make a network difficult to operate for the assigned people in a company. Complexity can be solved with more training for example
Variety in the elements of the network
The degree in which a network does not have a clear and straightforward design, and where consequences from a component failure cannot easily be understood through logical deduction.
High number of elements running a large number of processes, with a loose level of synchronization between them (aka, a non-linear combination of processes in a N-order connected topology).
Too many features in use.
Poorly designed networks, legacy and non-legacy networks interaction, networks built with one solution in mind being extended to fit other roles (poorly). Non automated provisioning causing frequent human errors. Lack of knowledge within Network Operations leads to bad operating decisions.
ISP, complex network
1) All things added by the complications departments. ;-) 2) All things that have the potential to make the network behave in very unexpected ways; these are mostly of the 'wrong assumption' kind. :-(
the design of the network and the services running over them... then new service comming and redesign it's needed <=> network complexity
An accumulation of 'special cases', deviations from a previously consistent architecture, which have to be taken into account for each new add/modify/remove to the design.
That which makes the network harder to completely grok.
Advanced configuration and complex routing scheme
Complex routing scheme combined with lots of nodes in the topology.
a bad network :p
in this survey the definition of network complexity has been: a state of the network that: makes it non-trivial to predict how traffic moves when an error of any kind occurs makes it non- trivial to understand why trafic flows the way it flows involves several protocols
The end-to-end combination of technologies and planes required to deliver network services.
many different protocols that all need to operate correctly to make the system work - too many interdependencies, hard to figure out where a given problem is originating from
Poorly documented
The number of variables dependent on each other in a given architecture (pieces of hardware, number of OSes, difficulty of configuration, result target, workarounds, etc). (This is certainly not the only definition.)
Inconsistent configs

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Hard to understand

unpedictability

Variety

dependencies

Wrong assumptions

Poor documentation

inconsistency

The Panel

- Geoff Huston
- Nico Fischbach
- Gert Döring
- Michael Behringer

Questions

- Examples of “catastrophic failure”: What caused the root failure?
- What makes your network complex?
- How do you contain / control complexity?

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- Wiki: http://networkcomplexity.org
  (please contribute!)