ING Container Hosting Platform, 3 years onward

Growing and sustaining a Private Cloud Container Hosting Platform

ING Tech Infra&Engineering

October 2022

do your thing

Introductions

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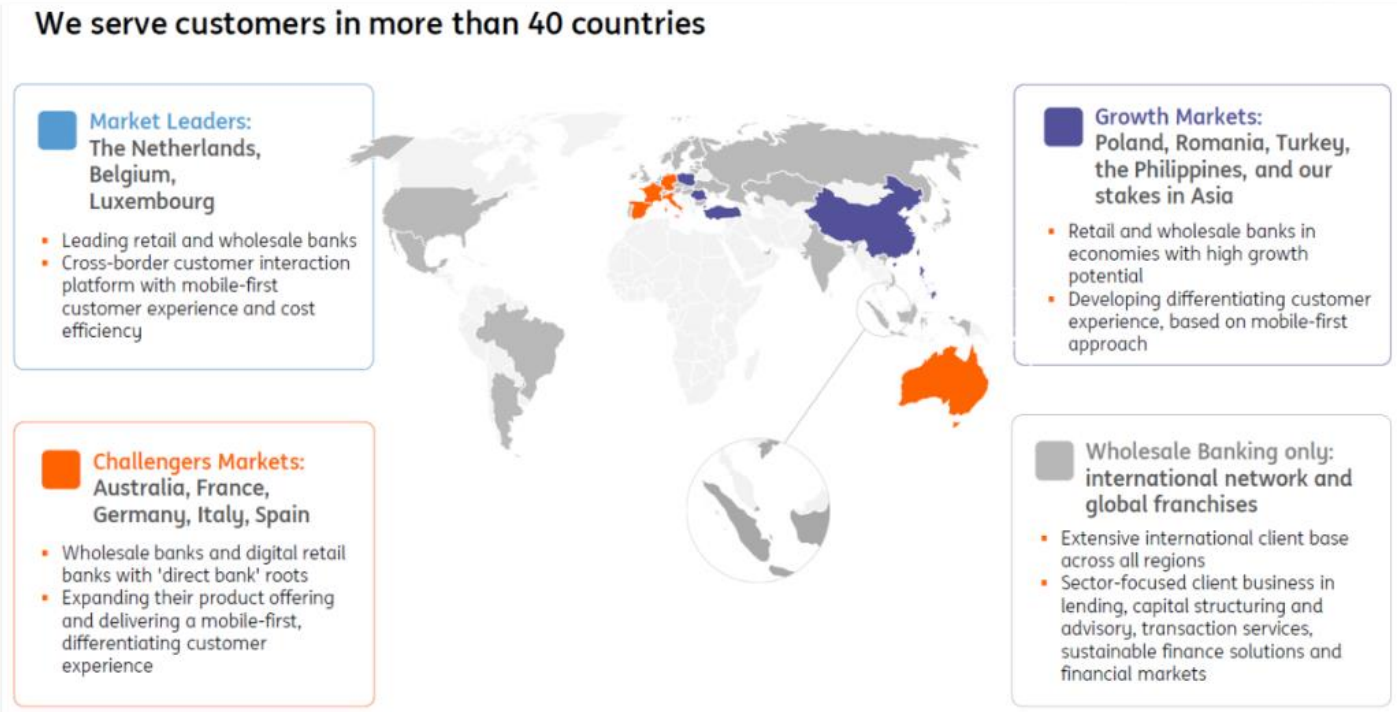
IT Area Lead ("Head of IT") for Cloud/PaaS, a.o. responsible for the delivery of ICHP towards internal customers.



ING is a global bank with a strong European base. Our more than 57,000 employees serve around 38 million customers, corporate clients and financial institutions in over 40 countries. Our purpose is to empower people to stay a step ahead in life and in business.

* ING is undergoing a transition to close our Wholesale Banking offices in Argentina, Brazil and Kazakhstan as announced on 5 November 2020. ING has exited the Austrian and Czech retail banking markets as of the end of 2021. We announced in December 2021 that we will leave the retail banking market in France after a strategic review of our retail banking operations there. We announced June 24th 2022 we will leave the Philippines retail banking market as of then end of 2022.

For ING's position regarding Russia and the Ukraine see our Feb 28 2022 statement

Short Recap

At 2019's San Diego OpenShift Commons ING presented "Running Containers in Production, the ING Story" where we introduced ING's Container Hosting Platform ("ICHP") and explained:

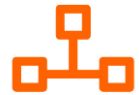
- the drivers behind our transformation
- the "Cloud Native ecosystem Kube" we use(d) to communicate with our stakeholders
- ICHP's deployment model & its delivery patterns
- which topics took the most time during the first 2 years of engineering and operation.

So for the remainder of this presentation we assume this content is known ;-)

and if not catch up afterwards :

So what happened since ? (aka agenda)

- *Covid…*
- Expansions
- Divisions
- Security
- LCM

- Exponential growth
- Bugs
- Resilience
- Partnerships
- (Refined) Strategy





ICHP –> ICH* (aka abstracting for multi cloud)

ING Container Hosting Platform (“ICHP”) was ING’s first **standardized Container Hosting environment**, but it has evolved into a family we now call **ICH** which consists of:

- The private cloud **ICHP** platform based on **OCP**
- The **ICHA** platform on Azure **AKS** (still being engineered)
- The **ICHG** platform on GCP **GKE** (still being engineered)

All these platforms abide to the same **defined interfaces** to enable **application portability** between the ICH family members, for both **re-useability** as well as **regulatory** reasons. And making deployments to multiple target clouds with defined interfaces mandatory will empower our engineers with the skills they need.

Why not use (managed) OpenShift on Azure & GCP ?

- ING believes the value of public clouds is in the integrated ecosystem and the cloud vendors native services will be the 1st to benefit from innovations in those ecosystems. This means we should consume SaaS rather then PaaS rather then IaaS to make use of those innovations as soon as possible.
- Hence we consume Azure and GCP native services wherever possible and we try to avoid IaaS services

For the remainder of this presentation we’ll focus on ICHP

*Note : 2 of our ING colleagues are presenting this KubeCon on “HPC Batch computing for Analytics Workloads “ (Wednesday 2:30 pm), attend and learn but be aware this environment is not (yet) hosted on ICH**

Divide & Conquer (aka Distinct Services deserve Distinct Treatment)

K8s technology = **Amazing**

- Almost **infinite #** use cases…

But

- Mixing multiple distinct use cases together in the same clusters = a **recipe for (regulatory) disaster**…

This table shows the attempt of ING to categorize in order to give each service its appropriate (risk&security) treatment.
white = (partially) available as a service
grey = currently not available as a service
This table is not intended to be static…

Meaning ING is **very opinionated** on what workloads should be hosted on our Immutable container hosting service…

Don't make any wrong assumptions, we do get **a lot** of requests for hosting software which in our opinion belongs on services currently unavailable (grey)

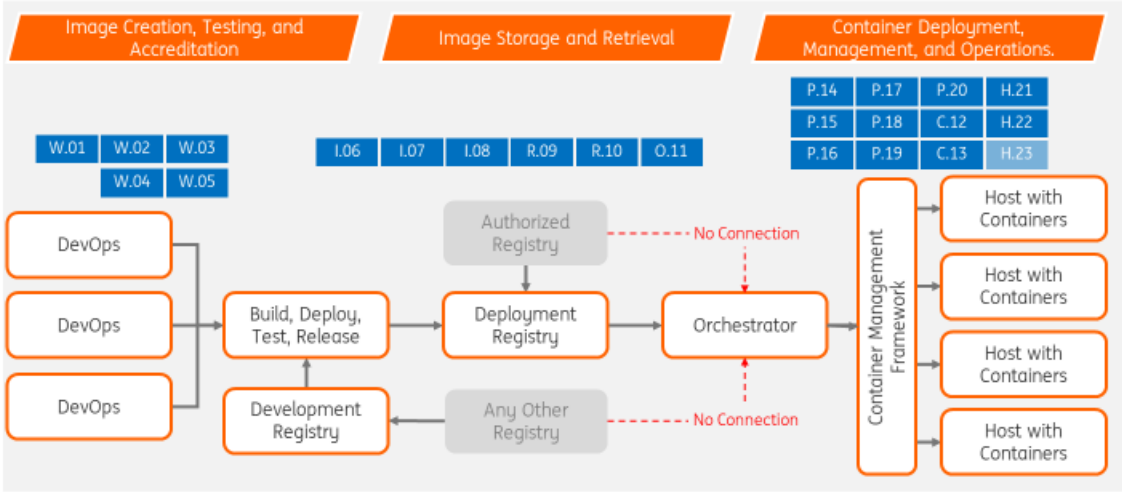
Service	Typical use case(s)
Immutable Containers	Capability to host immutable container workloads like 12 Factor Apps (commonly: "API's")
Functions as a Service	Capability to execute backend code directly without having to manage any servers
Data Services	Capability to provide data persistence as a service e.g. Object Storage, Elastic, Kafka, MS-SQL, Oracle, Cassandra, Redis, etc.
HPC	Capability to provide High Performance Compute (e.g. GPU, fast local cache, etc.) as a service for machine learning and analytics.
Centralized End-User	Capability to provide a managed, dedicated set-up for specific user(s) e.g. for data science, educational and training set-ups etc.
Infrastructure Management	Capability to manage IT assets as Desired State Custom Resources (e.g. Crossplane)
Non-12 factor apps ("VM"s) – K8S	Hosting of non-12 factor apps ("VM's in a container package"), typically large images containing monolithic applications, not ready for hands off operations, could be requiring managed local persistency. Hosted on a K8s or equivalent platform.
Standalone - Non-12 factor apps ("VM"s)	Hosting of non-12 factor apps ("VM's in a container package"), typically large images containing monolithic applications, not ready for hands off operations, could be requiring managed local persistency. Hosted on Standalone "Docker" instances.

"No" is a valid answer…, as ING Tech **chooses** to **focus** on a limited set (since we have scarce engineering capacity). Spinning up those other services would require additional DevOps squads to engineer and run those services. Requesters can still run that software on VM's…

Security

- ING Container Security Standard in place as of Q2 2019
  ("Zero Privilege", do not trust "Zero Trust"...)
- Comprehensive Vulnerability Scanning in OnePipeline enforced as of Q4 2021
  (thank you Log4J for the priority...)
- Immutable Workloads, enforced as of Q1 2022
  (privileged NPA's removed from production namespaces, Break Glass available, mandatory redeploy afterwards)
- Immutable Platform (Clusters), as of Q3 2022
  (OCP 4.10.30 IPI for Bare Metal dependency)
- Anomaly Detection & Policy-as-Code capability as of Q3 2022 (OCP 4.10/ K8s kernel version dependency)
- As of Q3 2022 ICHP has implemented all controls as specified in the Container Security Standard

Container Technology ING Security Reference Architecture



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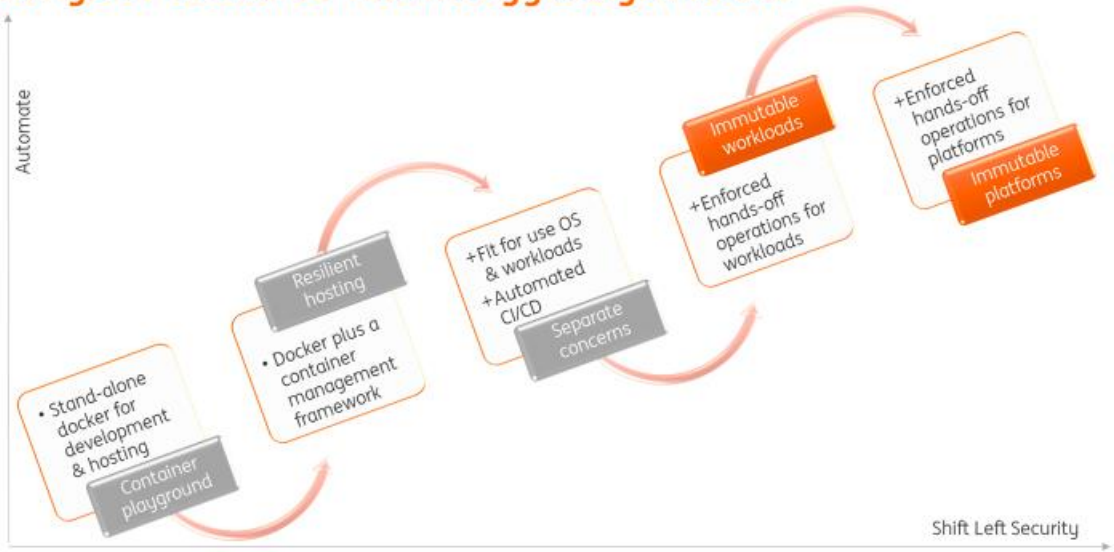
Range Of Container Technology Usage Models



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OpenShift LCM

Generic learnings:

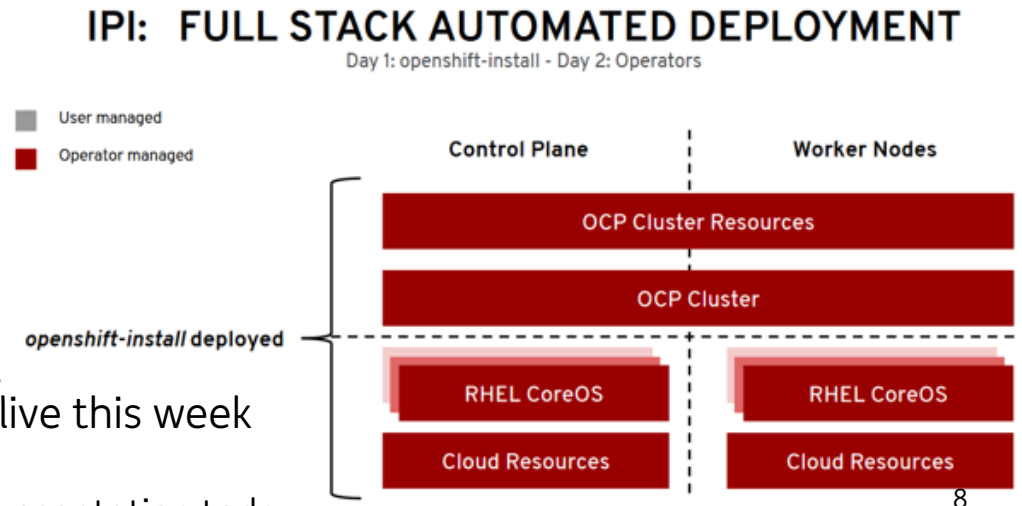
- Not all consuming DevOps teams understand the full scope of going Cloud Native and might be unaware of their shortcomings
- In particular we noticed the value of automated testing wasn't always recognized, which did hamper our Platform LCM
- Application redeployment should be "**the new normal**", not "something to be scared of"…

Migrating OpenShift 3.11 OKD to OpenShift 3.11 Enterprise (Q1 2020):

- Clusters were redeployed (1 DC at a time), forcing downtime (in practice a DR-excersize) upon our consumers. This wasn't well received and led us to rethink our migration strategy for the next LCM moment…

Migrating OpenShift 3.11 Enterprise to OpenShift 4.10 Enterprise ("ICHP v2") (Q3 2022):

- Running on Bare Metal nodes doesn't help if new OpenShift versions are first released for VM based clusters… It took Red Hat until version 4.10.30 to deliver the quality ING needed to do a fully automated IPI based install in our DC's *(which was kind of challenging looking at the EOS of OCP 3.11…)*
- This time we opted to spin up new clusters in parallel to the old environment, and offer our customers a migration window to redeploy their workloads. We opened the migration Sep 15th 2022 for our Non-Prod clusters and our Prod clusters are planned to go live this week



More details on how we build our NaaS on top of OCP 4.10 IPI in the other ING presentation today

Growing pains : exponential growth for Immutable App hosting

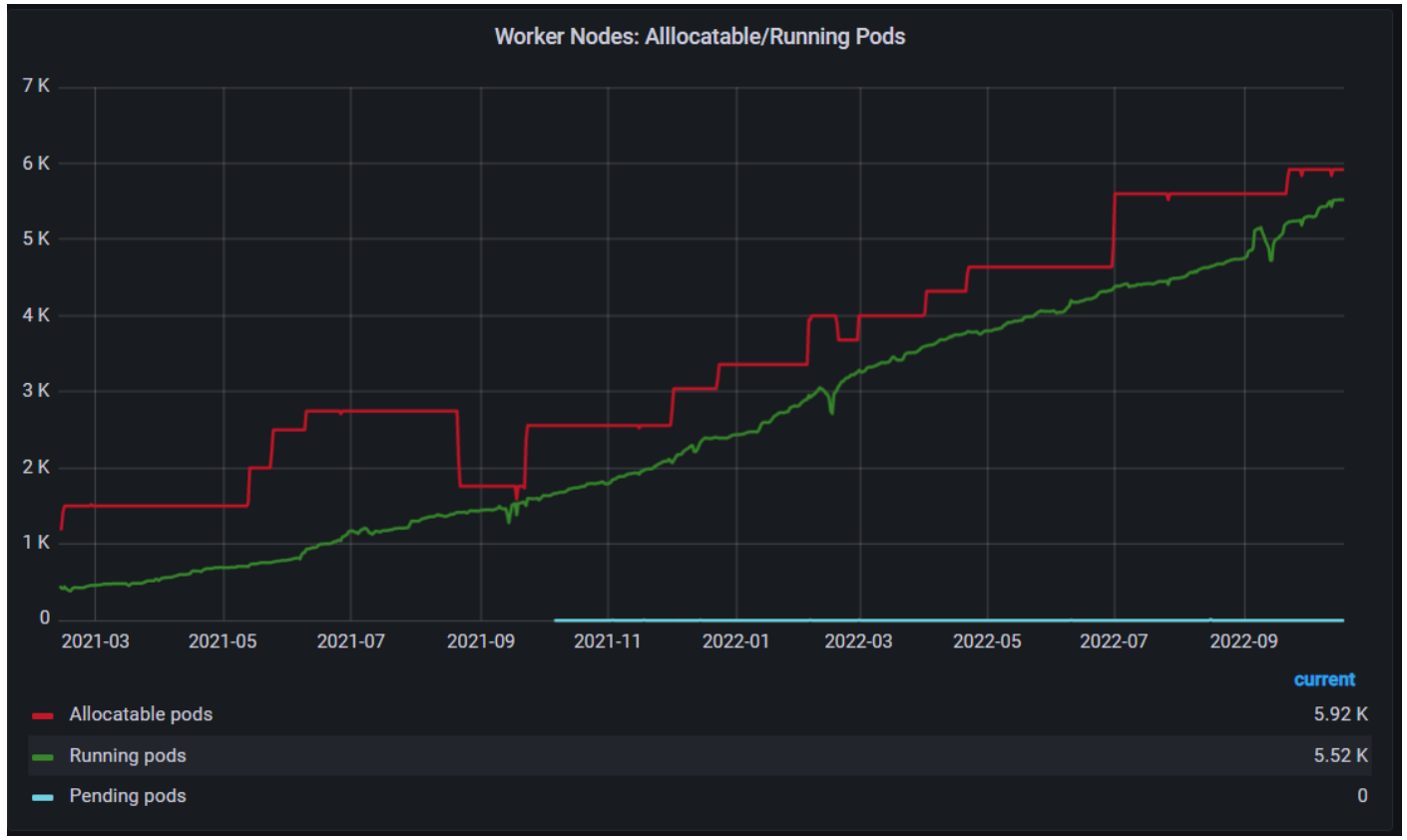
In Q3 2019 ICHP had 18 FTE and hosted :

- **250** Prod namespaces whose API's only processed a marginal number of transactions (most still preparing for actual workloads)
- about **1000** Non-Prod Namespaces

In Q3 2022 ICHP hosted:

- **600** namespaces in Production whose API's processed **50% of ING retail customer transactions**
- **1690** namespaces in Non-Production

And did this with **the same 18 FTE**, we only added an additional Ops squad to manage the environment (+6 FTE) from a partner (hired as of Q1 2022, for new total of 24 FTE)



So looking back ICHP coped with a **sustained 100% growth each year** (measured in installed CPU/memory capacity) (for the last 3 years) & this growth is expected **to continue** into 2023. As a result the price/unit has now become very competitive and ICHP's Immutable Container hosting in this way supports the broader ING Tech Strategy to **enable to grow our business at marginal cost**

Growing pains : Bugs (pending pods / pods per node)

Green line is actual ICHP Prod DC1 usage *(Prod DC2 usage is similar)*

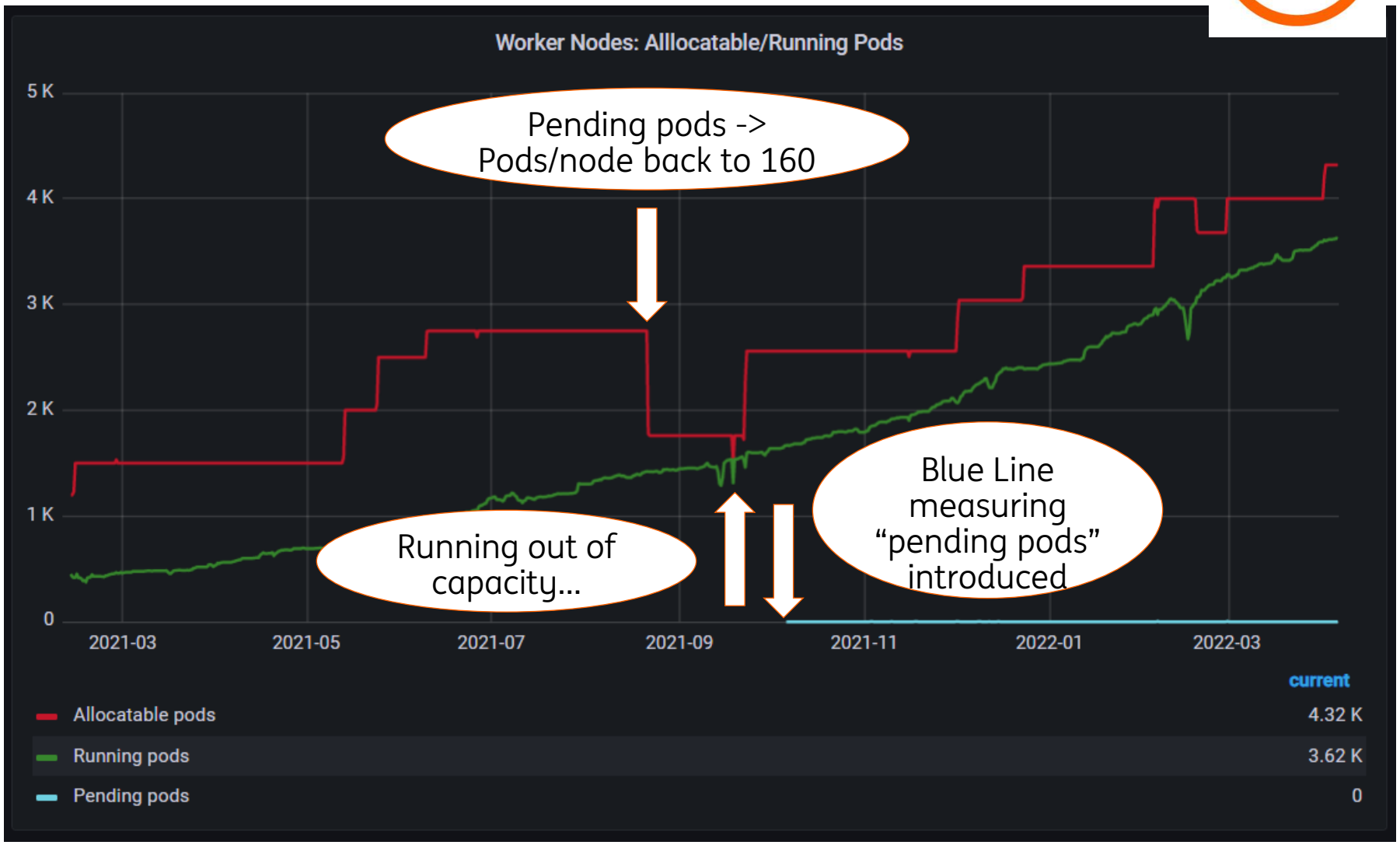
Red line is available ICHP Prod DC1 capacity *(Prod DC2 capacity is identical)*

Drop in capacity end of August '21 due to bug in OpenShift 3.11 icw Atomic requiring ICHP to scale back from 250 pods to 160 pods per node to become stable again (*with OpenShift 4/CoreOS its fixed*)

Customers were impacted (mainly in the non-Prod environment) in the Q3 2021 due to this shortage

As a provider we had to scavenge additional nodes everywhere to remain stable…

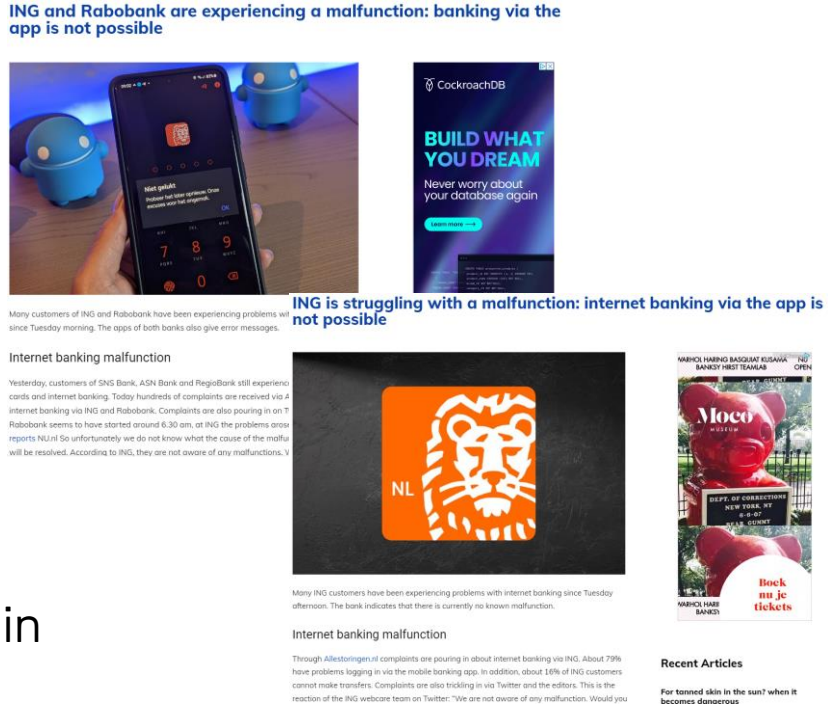
The drop in Feb 2022 was due to an unintended reboot of multiple nodes by one of our suppliers



Growing pains : workload resilience

Q1 2022

Multiple outages impacting ING customers on workloads hosted on ICHP (For the record : ICHP has had **zero** unplanned **platform downtime**…). Analysis concluded most **were avoidable**… by **properly defining K8s application deployment configs**. Lesson learned : Developer Autonomy is good thing, but never forget to validate the results…



Q2 2022

- ING CTO&CIO's decided on mandatory (not yet enforced) use of :
  - **canary releasing**
  - **resilient pod placement**
  - **liveness & readiness probes**
- ICHP published ING specific workload resilience documentation

Q3 2022

- ICHP provides Dashboards giving ING CIO's (& developers) insight in the quality of the deployments on ICHP
- Additional internal templates & resilience training materials being developed (by partner enabling teams)

Future Step : Policy enforcement via Policy-as-Code (K8s deployment config insufficient -> deploy job fails)

ICHP Partnerships

ING “BTP” (Topics & Service Mesh & Workload Deployment Templates)

ING “IPC” (DBaaS, Keyspace-aaS, Object Storage, Cloud Automation)

ING “Security Tribe” (IAM & Workload Security Monitoring & Workload Certs)

ING “MDPL” (Workload Observability)

ING “One Pipeline” (Workload CI/CD)

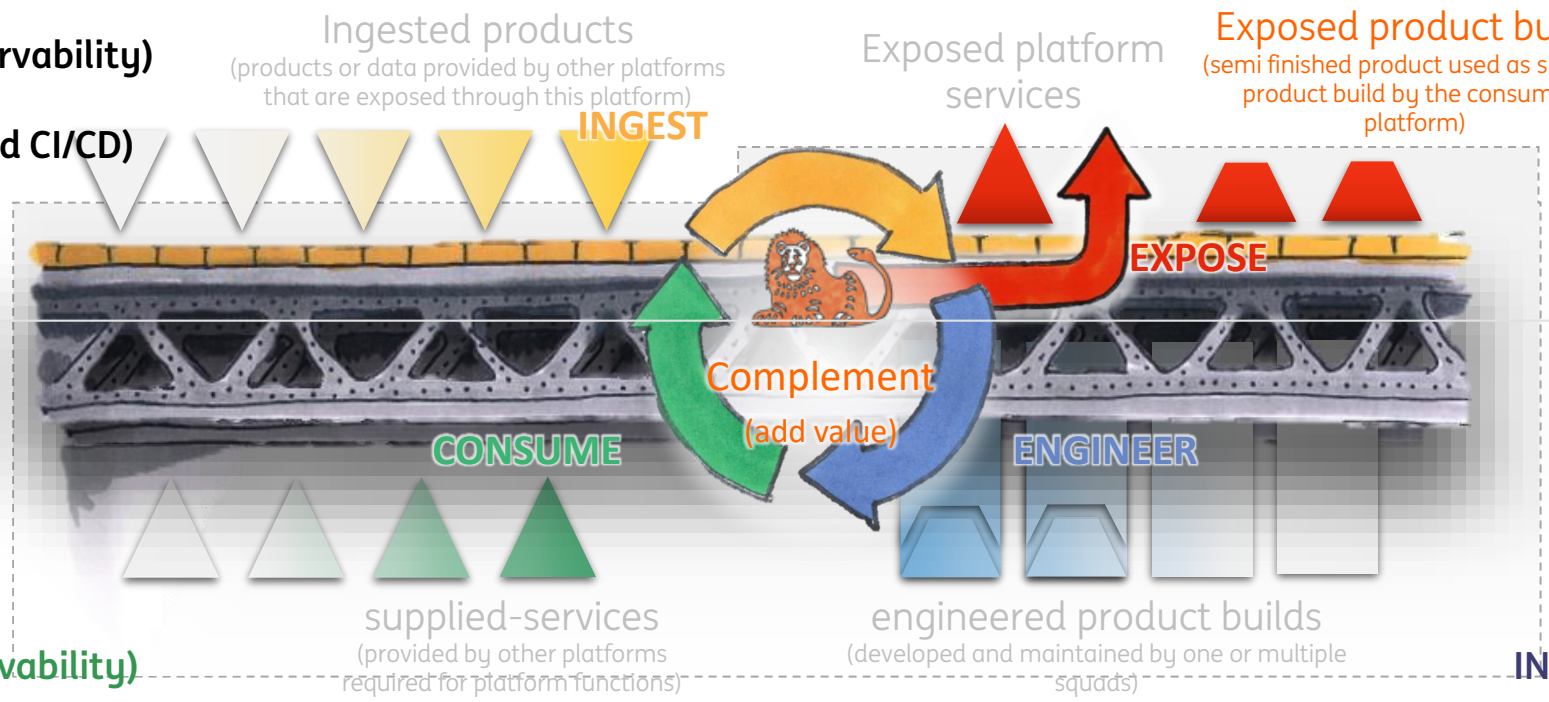
ING Banking Technology Platform

ING Group Services

ING Retail Banks

ING Wholesale

ING Infra&Engineering



ING “DCN” (Networking)

ING “IPC” (Object Storage)

ING “MDPL” (Platform Observability)

ING “One Pipeline” (Platform CI/CD)

ING “Security Tribe” (IAM & Platform Security Monitoring & Platform Certs)

ING “IPC” (Nodes BM & VM)

Red Hat (OpenShift)

Portworx (local persistency)

Strategy (part 1 : why do we do what we do ?)

ING's Tech strategy : "**To build Scaleable Tech which enables Growing our business at marginal cost**"

- ICHP is a core example of technologies engineered by ING to support this goal, as explained earlier

Additional Strategy goals are "**Self-Service**", "**Re-useability**" & **Automation**

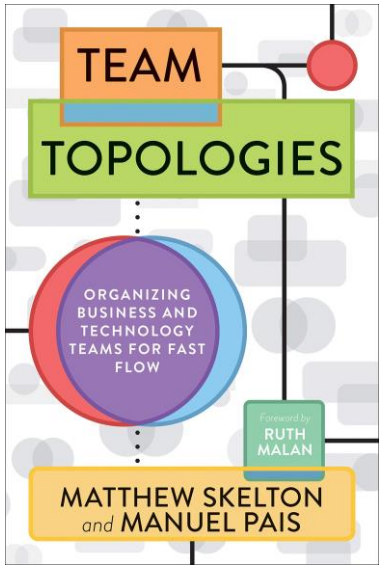
- The immutable container hosting is delivered as a Namespace-aaS from our private cloud portal
- The ICHP platform hosts applications from almost every ING segment and for most of the countries
- The ICHP platform is fully automated, both for Namespace & Cluster provisioning ("Immutable")

ICHP's Unique Selling Point : **Compliance-out-of-the-Box**

- **Immutability** is the key tool in achieving this goal. Hence ICHP focused on Immutable container hosting over the past period and this will stay it's core delivery

ING Tech is looking into "Team Topologies" as a way to optimize the internal organization and as it turns out ICHP ticks all the boxes for a "**Thinnest Viable Platform**" *(since 2018, the book was published in 2019…)*

Our platform is **compelling** for consumers, with our NaaS approach which **reduces** cognitive load, it **simplifies** the risk evidencing burden & we are strongly **partnered** with key "stream aligned", "enabling" & "platform" teams in different ING segments to help guide our backlog/roadmap



Strategy (part 2 : what's next?)

For the Immutable container hosting service there's still work to be done:

- **Pets** -> **Cattle** for the clusters, which is aided by
  - **Hypervisor based Nodes** (currently all production is on Bare Metal)
  - **Multi-Cluster Management ("MCM")** : Pattern(s)/Solution(s) to be investigated
- **Anomaly Detection** and **Policy-as-Code** capabilities have been released with ICHPv2 based on OpenShift 4.10, but scope wise we have lots of opportunities to expand rulesets… **Workload resilience** will be high on that backlog…

But ING does recognize other K8s use cases as explained before:

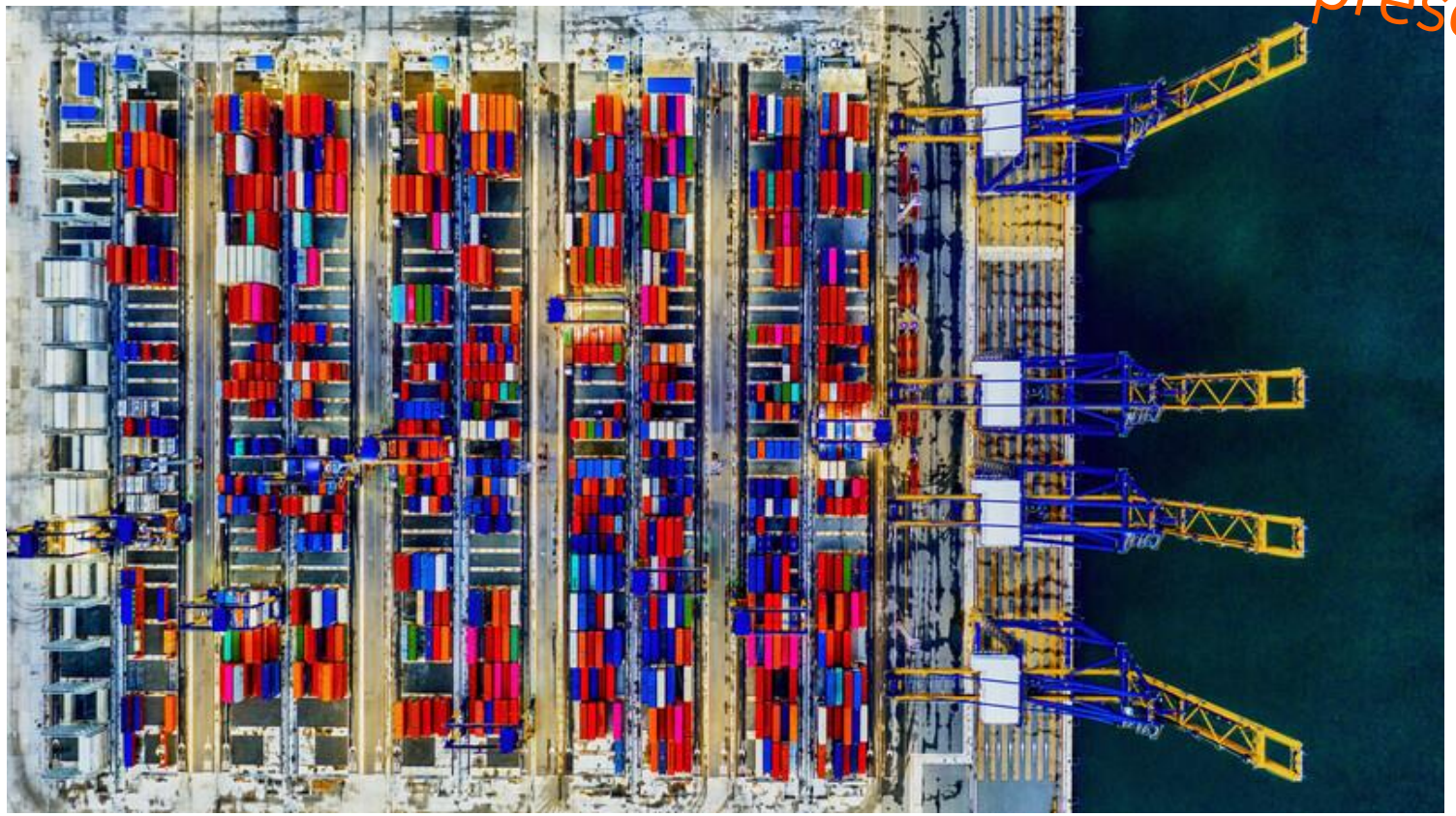
- ICHP is hosting **Elastic & Prometheus** environments on dedicated OpenShift clusters (with local persistency)
- ICHP is working on a Cluster-aaS delivery for Platform Teams
- And ICHP is tracking the maturity of the market:
  - To determine when best to start investing our scarce engineering resources (Scarcity does create focus…).
  - The **Multi-Cluster Services** ("MCS") developments have our special attention (perhaps Skupper + KCP…?)

In the mean time non-Immutable workloads can still be hosted on our Private Cloud VM offering…
(no exceptions/no specials in our multi-tenant Immutable Container hosting, or else we risk losing our USP…)

Last but not least we strive to be a more engaged participant in the community, more on that topic in the other ING presentation today…

Thank you / Questions

Save Namespace-aaS questions for the other ING presentation please



Of course we're hiring ;-)
https://www.ing.jobs/tech

Slides will be made available at
https://www.slideshare.net/ThijsEbbers/


Appendices
Additional materials for your understanding

Meanwhile, in Non-Prod…

Whilst we treaded the eye of the needle in our Production clusters when we hit the “Pending Pods bug”, we weren’t so “lucky” with our Non-Production clusters.

On several occasions consumer (DTA) workloads did encounter negative impact, and since hardware replenishment was difficult we moved D/T workloads to newly added VM based nodes (which explains the decline in the green line) in order to free up Bare Metal nodes to be used to stabilize the Production clusters as well as to keep the Acceptance workloads as stable as possible on the remaining Bare Metal nodes

ICHP('s-ecosystem) enabled our Internal ING Customers to achieve :

- From ING's Daily Banking Tribe talk at GOTO 2022 conference ("Spotify Model : On Radical Improvements From The Trenches Of Change"):
  - Deployment time : 62% build & deploy speed improvement
  - Development capacity : 27% more Backlog items done (measured per year in 2020/21)
  - More Coding : 16% more coding time per team
  - No more VM's : Less infra costs, no patching, more secure, less issues with auditing the stack

  (More cool ING Tech talks on our YouTube Channel)

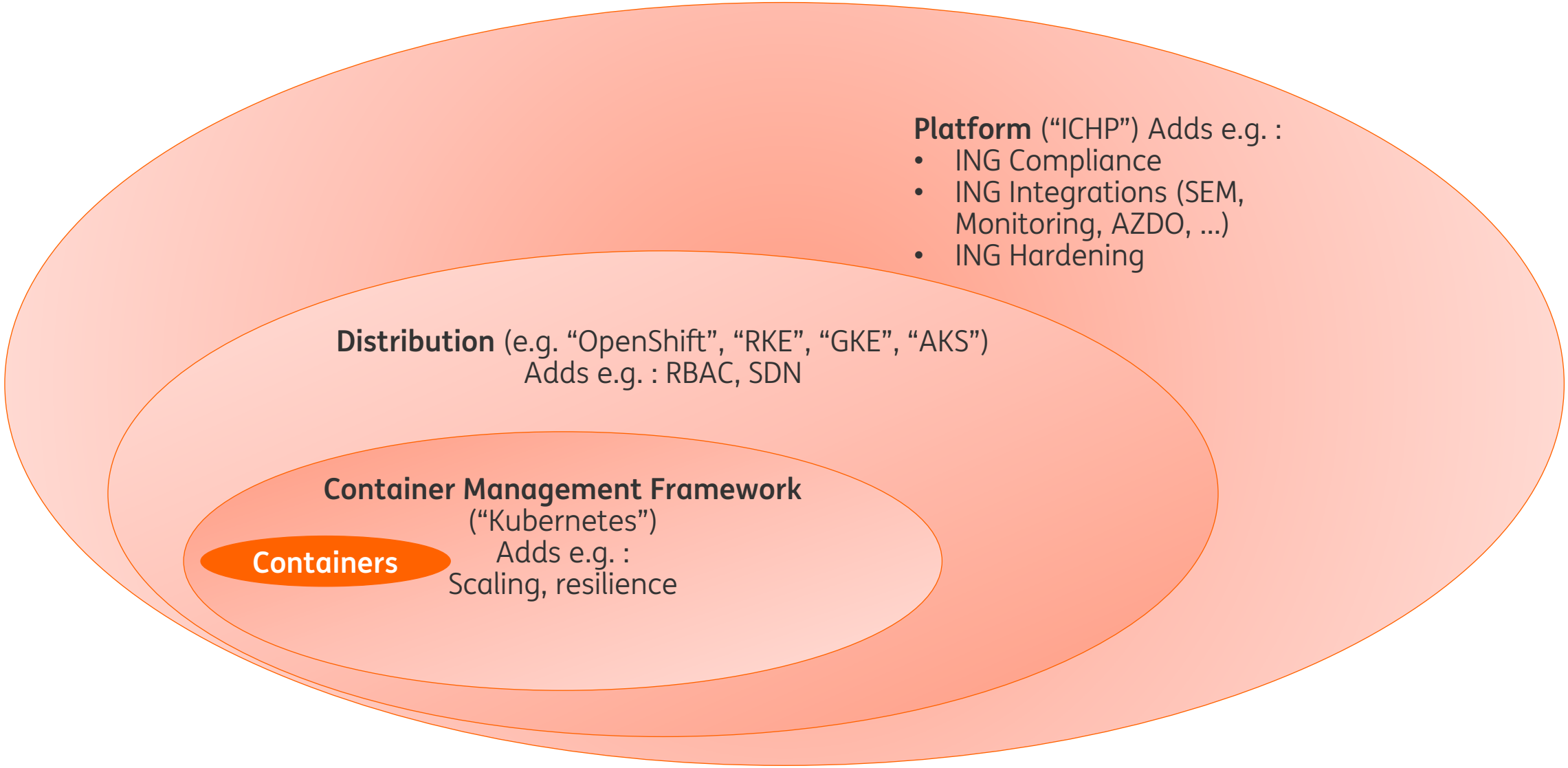
- Building a Global Investments Platform in 12 Months (2020-21)

- Building a Digital Platform for Insurance Products ("ING-AXA partnership") in 9 Months (2019)

- Building a (Mobile Only Digital) Bank in 9 Months ("The Manila Miracle") (2018)

- And more to come...

Application Containers to Container Hosting Platforms



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ICHP Immutable App hosting Intended Use

- Important aspect to be taken into consideration: The ING Container Hosting Platform Immutable Container hosting is NOT aiming to rehost VM's to containers… Purpose is to have the best possible hosting environment for immutable workloads!
  - If a DevOps teams manages to properly refactor their VM into a set of container images they are welcome
  - Hands-off approach in production (which implies a mature team in all aspects, e.g. CI/CD !)

  If teams feel not comfortable with this they should stay on VM's!

Why ICHP only offers a “Namespace-as-a-Service”

ING aims to make our DevOps teams autonomous (As explained in ING’s Way-of-Working in 2019) .
We also want to enable those DevOps teams to deliver maximum value to the business, by not bothering them with IT-Infrastructure concerns, nor bothering them with having to deliver compliancy evidence for the hosting platform.

Hence offering a Namespace-as-a-Service is for us the sweet spot:

- Clear demarcation between (Infra)Provider and Consumer
  - Enabling hand-over of compliance evidence
  - Enabling multi-tenancy (hence fast time-to-market/self-service consumption, and the potential for efficient utilization of resources)
- The DevOps team can assume responsibility for (almost) the full stack (only the kernel stays shared). They have liberty/responsibility to choose/maintain their (versions of) base image, runtime engine, libraries, etc. *(within the boundaries set by the ING corporate risk&compliancy rules !)*

ING will offer a K8S Cluster-as-a-Service in the future, however this will be a limited offering only available to selected platform teams.

Cloud Abstractions

Key Objective for ING is to remain capable to exit a Public Cloud provider.
Determining the right abstractions is key to meeting this objective for a container hosting platform, hence:

- We choose an open/industry standard (in this case: the Kubernetes ecosystem)
- We choose an intended use (in this case: Immutable Workloads)
- We clearly define the allowed interfaces (in the ICH – Interfaces standard)
- We automate our deployments by the mandatory use of One Pipeline

Note that these abstractions are design time and not runtime (*as we still use the AKS service native to Azure or the GKE service native to GCP*)

However there will always be debate on the details as we try to balance innovation, time-to-market, risk/security and/or cost-income ambitions. Therefore actually running production workloads on at least one Kubernetes stack outside of the primary (Public) Cloud provider is the best recipe to “keep everyone honest”, as this will prevent Cloud Provider specific “optimizations” from slipping into ING code. Meaning there should always be at least 2 ICH standard solutions in use.

Dive and Conquer additional information

We do know how to build those services in grey… Our engineers are more then capable to build and run those. But not all of them together at the same time…

Hence for each year ING determines where to allocate that engineering capacity:

- Improving existing services
  - e.g. Pets -> Cattle
- Supporting additional use cases on existing services
  - e.g. Data Services we today only support ELK & Prometheus, if we start to support Data Persistence Services more critical to the bank (e.g. message bus, (non-)relational databases) we'd actually like the availability of those Services to be independent from K8s cluster uptime (hence our interest in CNCF MCS developments)
- Introducing New Services
  - We do have active instantiations of Centralized End-User & HPC use cases on K8s in ING (one is even presenting @KubeCon Detroit). But those are currently not hosted as a centralized/standardized Service. So we could also choose to include those in the ICH catalogue
  - The one defined service we're not likely to invest time in any time soon is FaaS, that has everything to do with the controls currently enforced from a regulatory perspective and little with the actual technology…

IPC/ICHP hosting services (1/2) (Grey is currently not available)

Service	Typical use case(s)
Immutable Containers	Capability to host immutable container workloads like 12 Factor Apps (commonly: “API’s”)
Functions as a Service	Capability to execute backend code directly without having to manage any servers
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IPC/ICHP hosting services (2/2) (Grey is currently not available)

Service	Unit of Delivery (/Security)	Local Persistency	GPU	Ingress	Exposed interface(s)	End-user access to SSH/Terminal Interfaces
Immutable Containers	Namespace	Not Available	Not Available	Shared per Traffic type (Internal/DMZ/...)	**API** (HTTPS ingress), **Eventing** ("Kafka"), **File** (/Object) ("S3")	Not Allowed (in Production) *(currently still tolerated in Non-Production clusters)*
Functions as a Service	Function	Not Available	TBD	Shared	See "Immutable Containers"	Not Possible
Data Services	(set of) Namespace(s)	Available	Not Available	Dedicated per workload	TBD	Not Allowed
HPC	Namespace	Optional	Optional	TBD	See "Immutable Containers"	Not Allowed
Centralized End-User	Namespace	TBD	TBD	TBD	SSH/https/...	Allowed
Infrastructure Management	Control plane	Not Available	Not Available	Not Applicable	K8s API	Not Allowed
Non-12 factor apps ("VM"s) – K8S	Namespace, VM ?	TBD	Not Available	TBD	TBD	TBD
Standalone - Non-12 factor apps ("VM"s)	VM	Available	Not Available	Dedicated	No restrictions	Available

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Security additional explanation

“Immutable” =

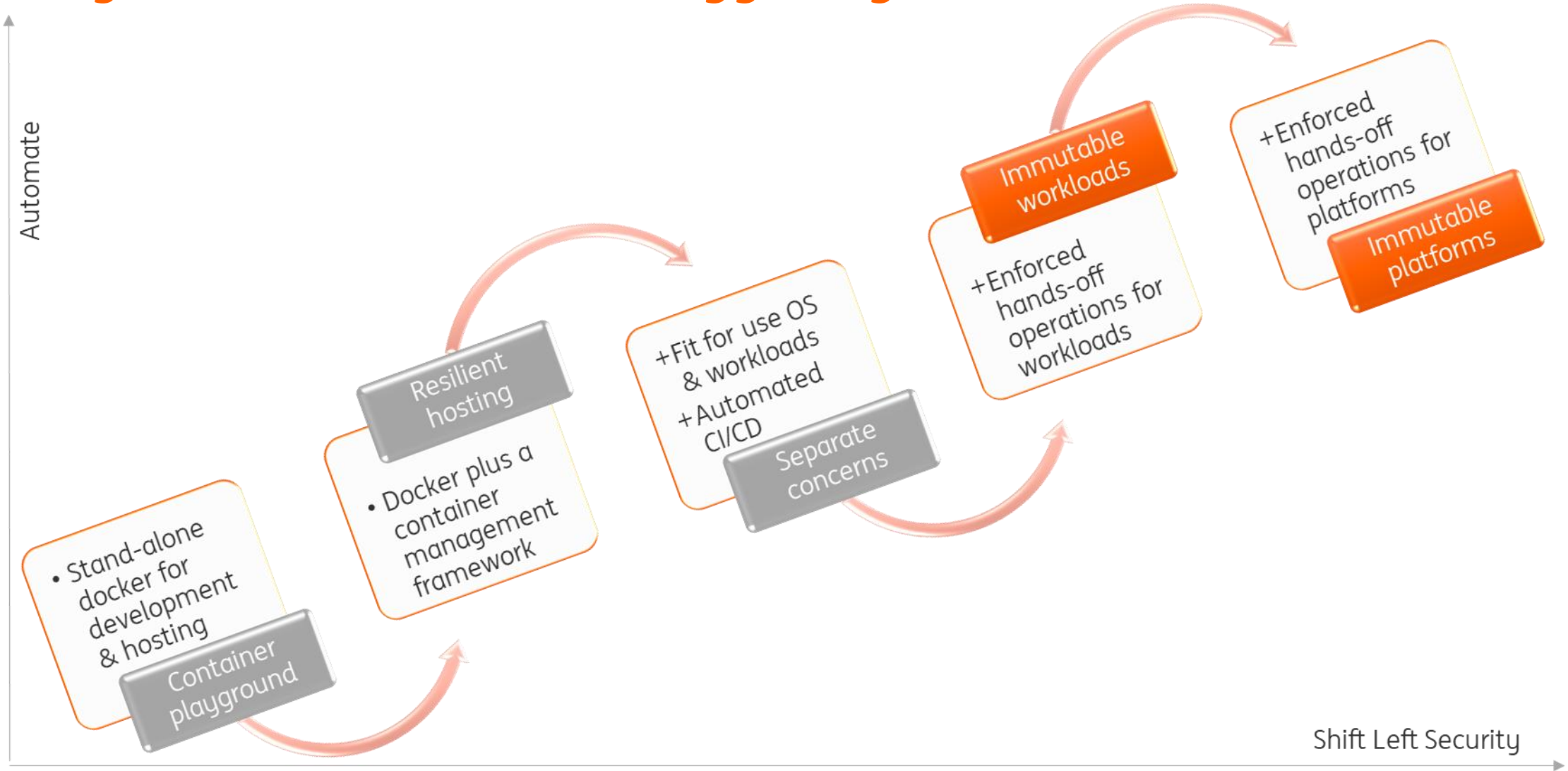
- Any change can only be executed via an ING pipeline which has all required checks & balances in place (and which facilitates automated evidencing for regulatory purposes)
- In short : no direct access for natural persons, no change privileges for other systems

And yes, ING’s Container Security Standard was in place before “Solarwinds” reached the headlines in 2020…

And although most people in the IT(-Security) industry are now aware of the software lineage issue exposed by it (that doesn’t mean its anywhere near solved…), far too few understand it’s 2nd lesson about the dangers of overprivileged software… (what enabled those attackers to move laterally so easily…?)

For these 2 reason ING does not trust “Zero Trust” labelled implementations as very few of those have actually covered these concerns properly…

Range Of Container Technology Usage Models



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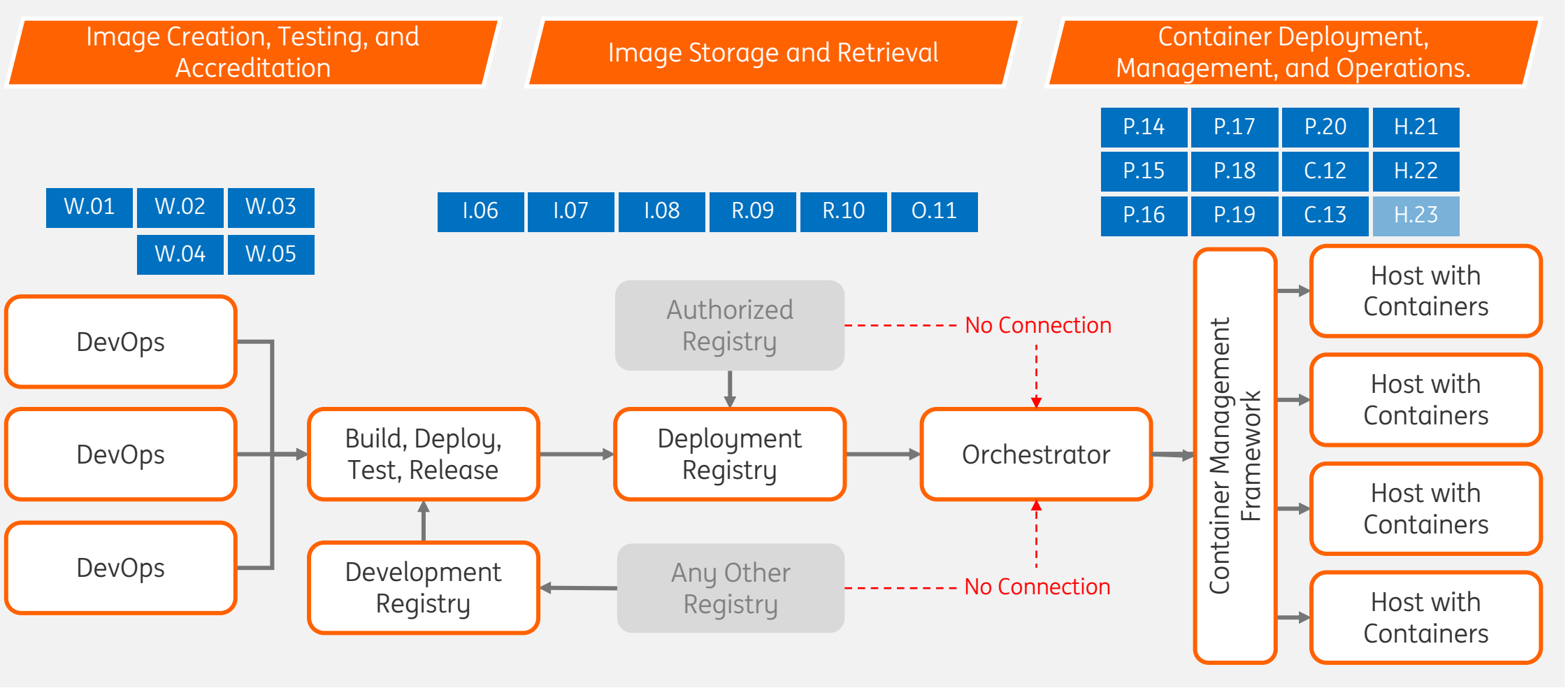
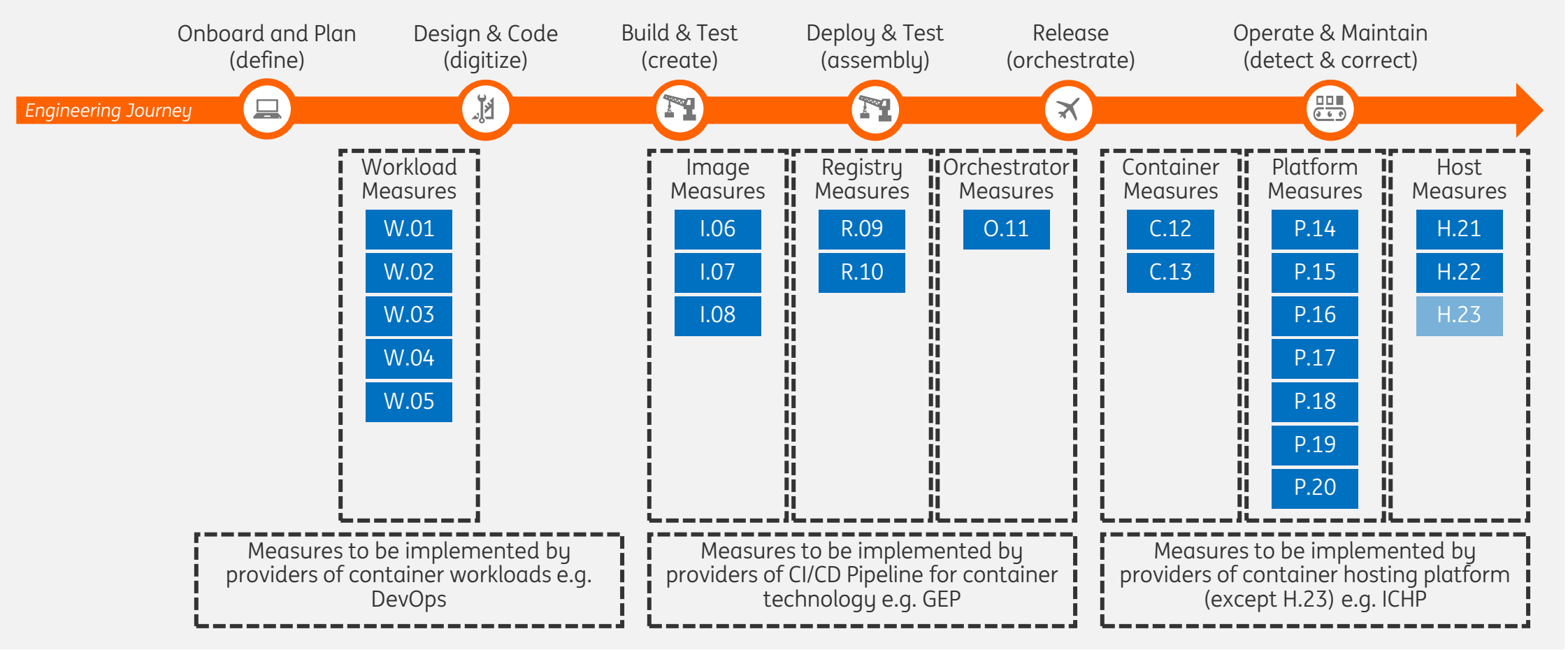
Container Technology ING Security Reference Architecture



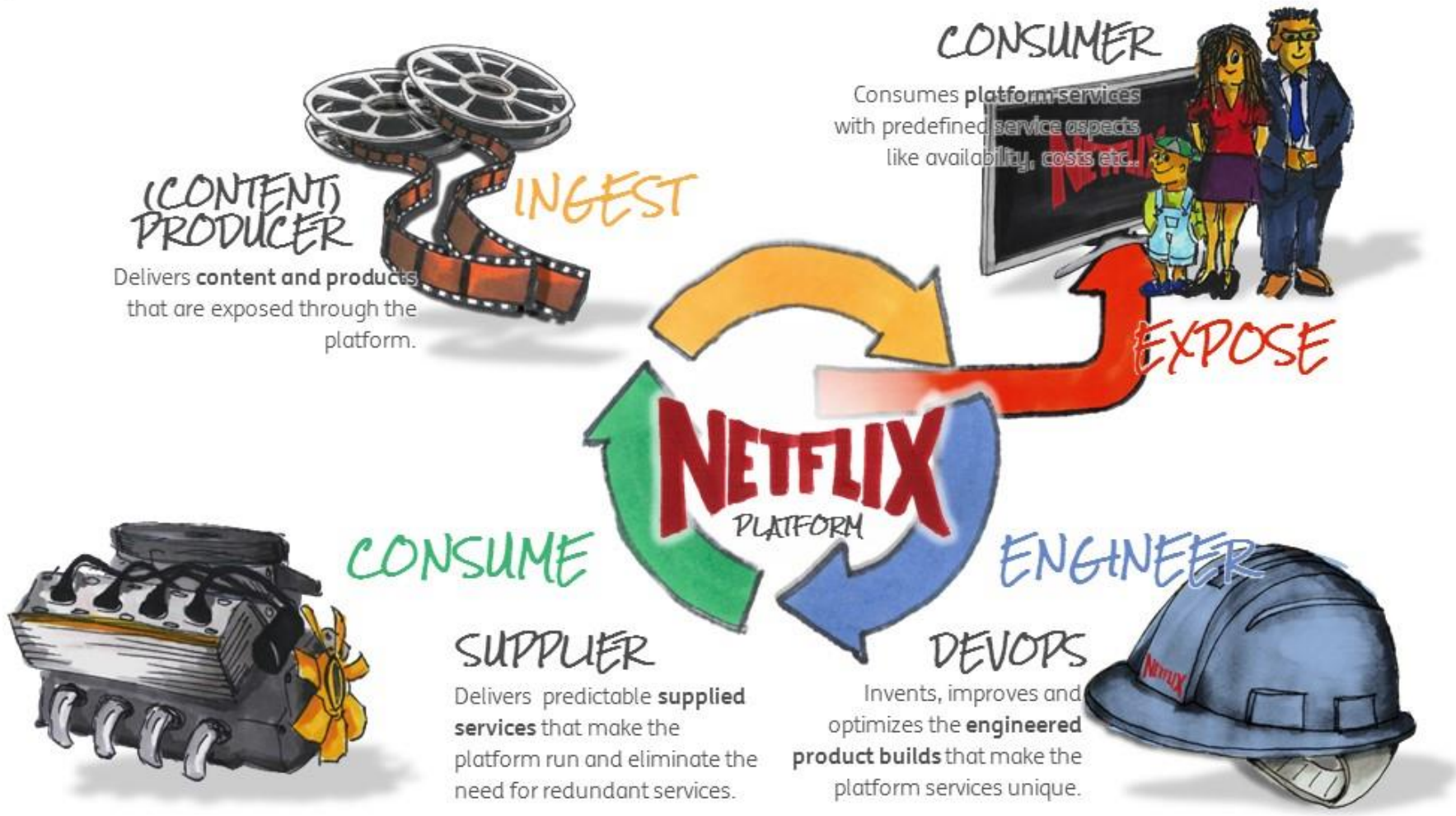
Container Technology Security Measures Overview



Workload Resilience : As an ICHP Consuming DevOps Team, I

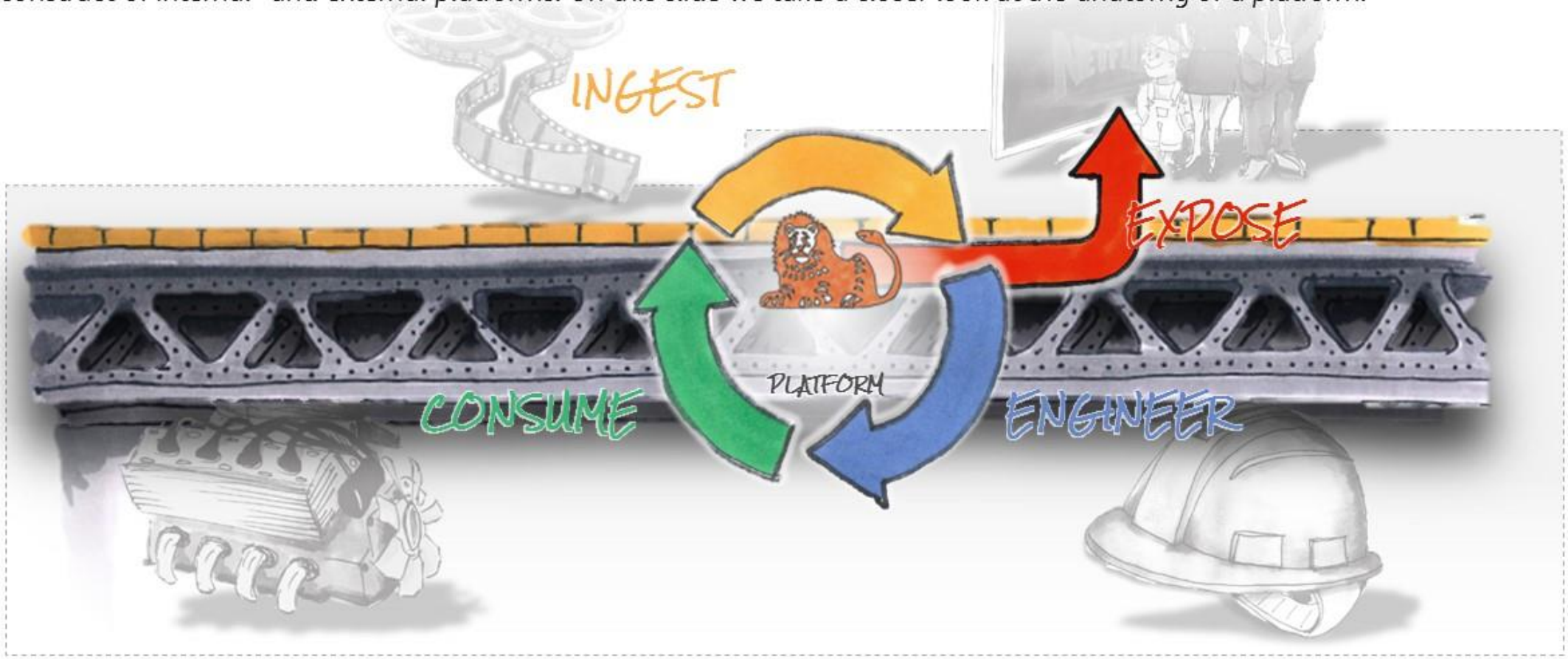
- Want to understand how to :
  - *Use **Canary (Blue/Green) releasing** using K8s cluster external loadbalancing services*
  - *Use **Canary (Blue/Green) releasing** using K8s cluster internal capabilities*
  - **Revert** my traffic 100% to my stable version in case of unexpected issues
  - **Rollback** my release to the N-1 version in case of unexpected issues with version N
  - Perform **Resilient Placement** so a single Red or Blue outage in the underlying IaaS layers will not affect my application availability
  - Implement **Liveness Probes** so my pods will restart automatically in case of applicative issues
  - Implement **Readiness Probes** so I have the input to automatically direct my traffic in case of applicative issues
- And would like to see examples & templates how to use above features in ING's One Pipeline

A PLATFORM


(CONTENT) PRODUCER
Delivers **content and products** that are exposed through the platform.
INGEST
CONSUMER
Consumes **platform services** with predefined service aspects like availability, costs etc..
EXPOSE
NETFLIX
PLATFORM
CONSUME
SUPPLIER
Delivers predictable **supplied services** that make the platform run and eliminate the need for redundant services.
ENGINEER
DEVOPS
Invents, improves and optimizes the **engineered product builds** that make the platform services unique.

THE ANATOMY OF A PLATFORM

The ING ecosystem -as part of the larger business ecosystem we reside in- is to transform into a purpose driven highly dynamic construct of internal- and external platforms. On this slide we take a closer look at the anatomy of a platform.



Strategy additional explanation

The following slides come from ING Investor Update June 13th 2022 Tech& Operations

Scalable Tech & Operations is a key enabler of superior customer experience

Reusability

Designing and building once, reuse in countries and segments

Modularity

Breaking up customer journeys, facilitating differentiation and optimising reusability

Self service

Easier onboarding and usage of modules locally

Automation and digitalisation

End-to-end straight-through-processing

Shared services and capabilities

Hubs leveraging expertise and using scale to drive productivity

- Seamless digital experience
- Shorter time-to-market
- Consistent high quality
- Lower cost-to-serve

Benefits of our scalable Tech foundation

Our scalable Tech foundation

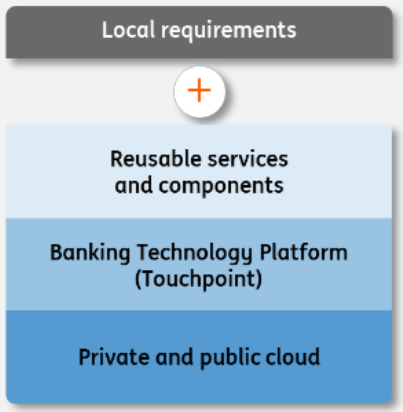
Reusable services and components

Banking Technology Platform (Touchpoint)

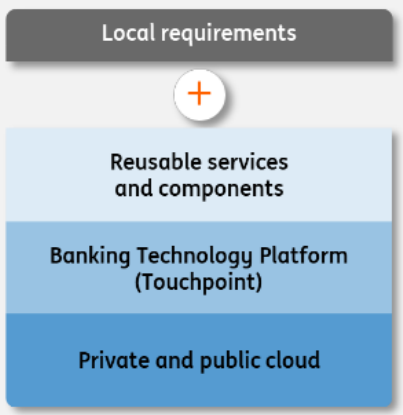
Private and public cloud

Used by countries

Proposition A



Proposition B



Benefits

- Shorter time-to-market
- Consistent high quality
- Increased productivity
- Lower cost-to-serve

Construct your own Kube

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do your thing

DMZ
Load balancing
Firewalling
The networking platform exposes relevant services to the container platform
ING
The Cloud Native ecosystem Kube
A model of a Cloud Native ecosystem without local persistency ("12 factor") and fit for a regulated Enterprise
Purpose: To make you familiar with the concepts and terminology
Not to be confused with CNCF's Cloud Native landscape. (https://landscape.cncf.io)
Functions / Services
Listening on Topics
Monitoring / Alerting
SIEM
Reporting
Charging
?????
Tablespaces
Buckets
Others
Topics
Data Services
Data
SIEM
Vulnerability scanning
Technical state compliance monitoring
Identity and Access management
Directories
Certificate management
Password Vault(s)
Security Services
Deployment config
Replica's
Ingress/Routes
Services
Internal Firewalling
Account source definitions
Certificates source definitions
Passwords source definitions
Binding 1
Binding 2
Binding n
Code
IMAGE
Container image
Network config
Load balancing
DMZ's
External Firewalling
Delivery responsibility of the DevOps Team
Scanning Engines
Release orchestration
Legacy Onboarding
(create SLA, change SLA, terminate SLA)
Code repository
Artifact repository
CMDB
Repositories
Code, artefacts and configuration
The CD/CI platform supports/manages the creation of deployable artifacts, either via a pipeline or via legacy methods (portals...)
Namespaces
Other
Instance 1
Instance 2
Instance 3
Instance 4
Namespace / SLA
(e.g. 4 CPU / 32 GB)
Node 1
Node 2
Node 3
Node 4
Node n
Nodes with other cluster functions
Cluster 1
Cluster 2
Cluster 3
Cluster u
The container hosting platform consists of a collection of clusters (prod/non-prod, dispersed over DC's)