Trust and Resilience in Modern Sovereign Infrastructure

Karanbir Singh, Senior Distinguished Engineer
Red Hat (UK) Ltd

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Trust me when I tell
you not to trust anyone !

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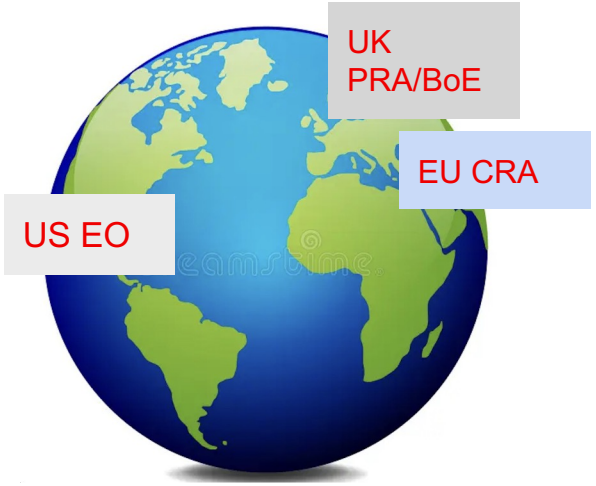
Open Source Won

And with it comes the winners burden

Why Trust & Resiliency Matters?

- Every industry runs on IT
- Growing **regulatory pressures**
- **Geopolitical** Pressure & Risks
- Continuity and confidence = **business critical**



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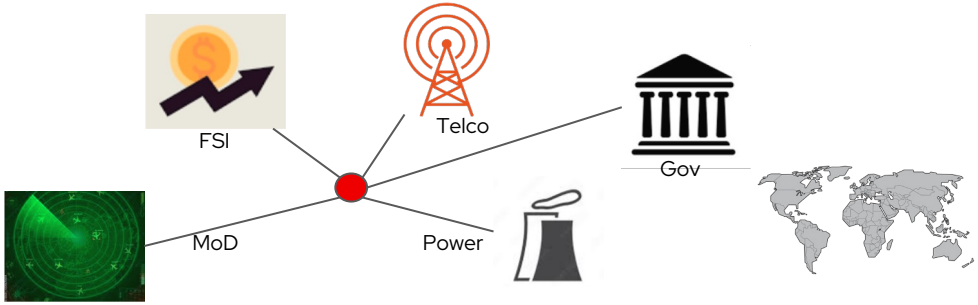
Regulated Consumers are well entrenched in the Open Source ecosystem today



It Is

- Regulated
- Defined / Assertable
- Dynamic

It Can be

- Geo / Political
- Industry Specific
- Posture Driven

It is not just (*)

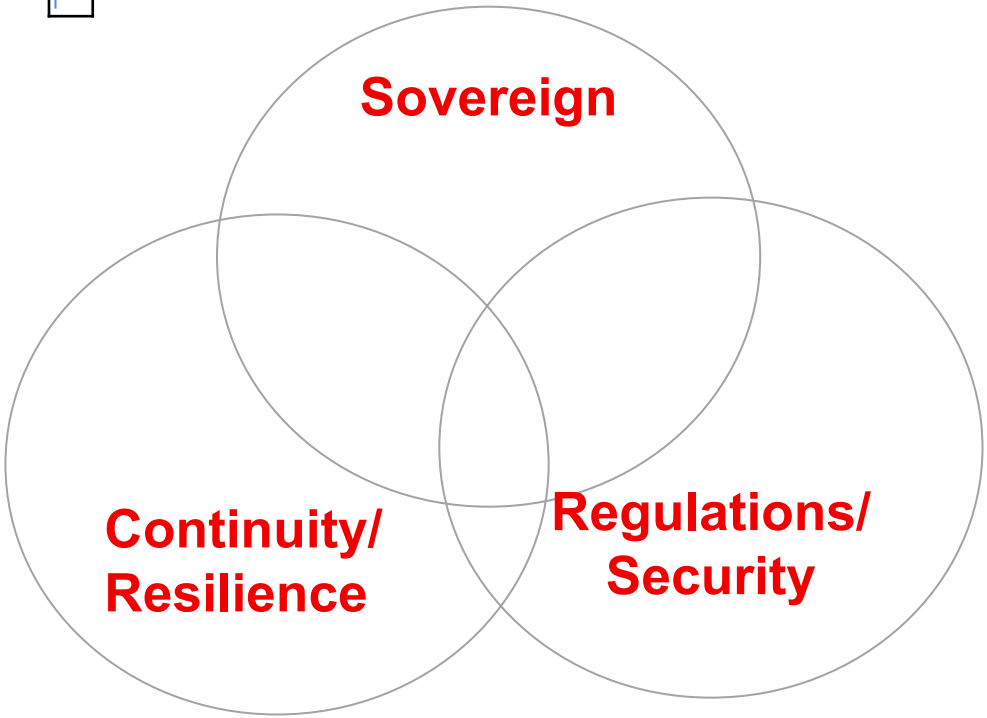
- Private
- Disconnected
- On Prem

Enabling, at reducing cost { people, time, tooling }, is a key aspect of maturity.

Cascading value, Realisation of common context, Consistently

(*) : We get private, disconnected and on-prem as a by product of execution, but these are not goals in themselves

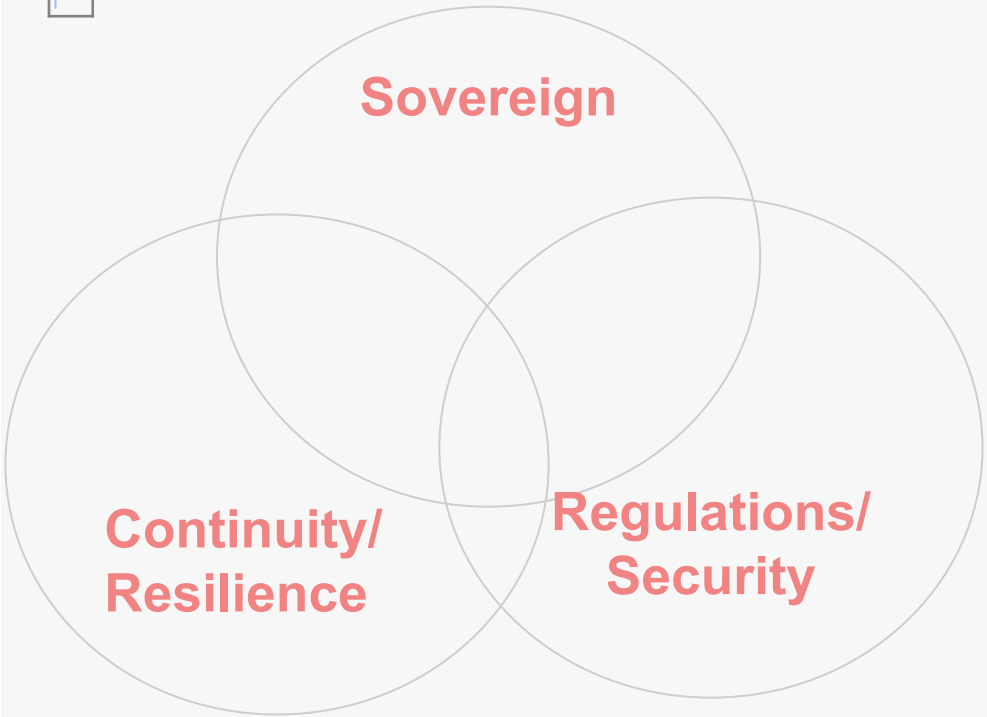
Multi-Dimensional Challenges



- Sovereign: Who controls data/code?
- Critical infra: Can I recover at scale?
- Regulations: Can I prove compliance?

Always under cost & speed pressure

Multi-Dimensional Challenges



- Sovereign: Who controls data/code?
- Critical infra: Can I recover at scale?
- Regulations: Can I prove compliance?

Always under cost & speed pressure

What's your Malware Story ? Your Ransomware push back ?

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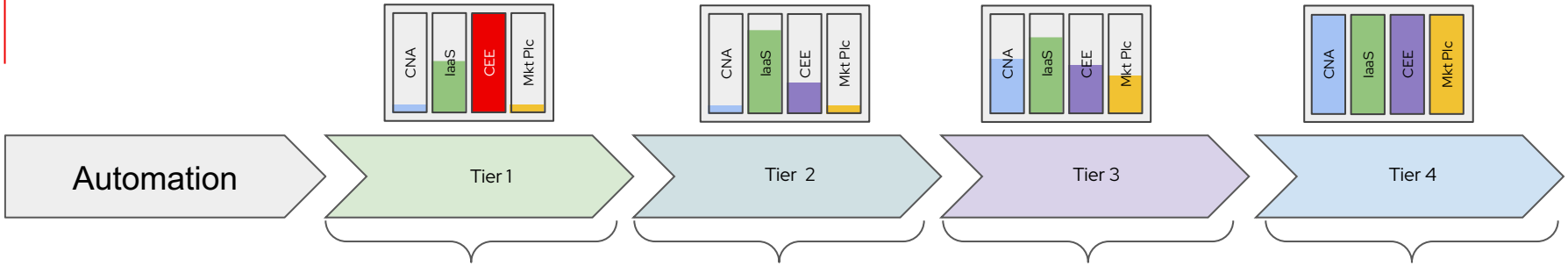
IT Systems are getting complex



Dependent of customer journey - where they are and desired outcome —>

Self Service

Cost Management

Compliance

Observability

Continuity

CNA : In Cloud Assets

Failure Domains

Ecosystem

High order : eg. GPUaaS

Global Availability

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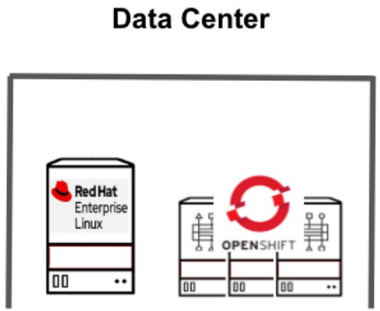
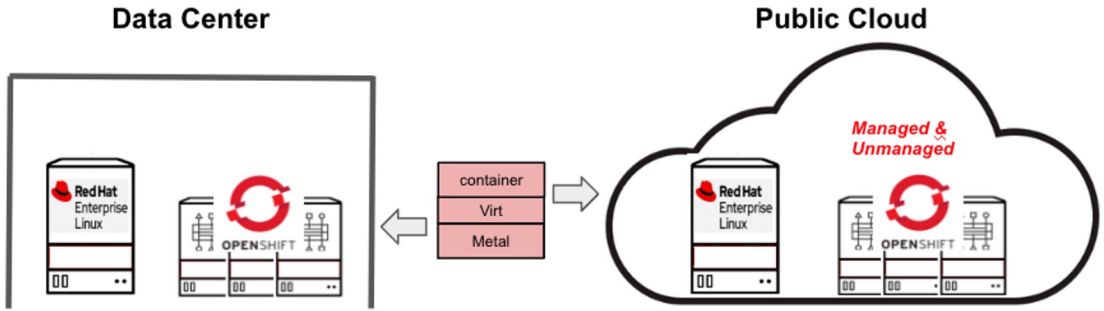
Management Topology - Hybrid Infrastructure & Hybrid Cloud



Management Topology - Hybrid Infrastructure & Hybrid Cloud



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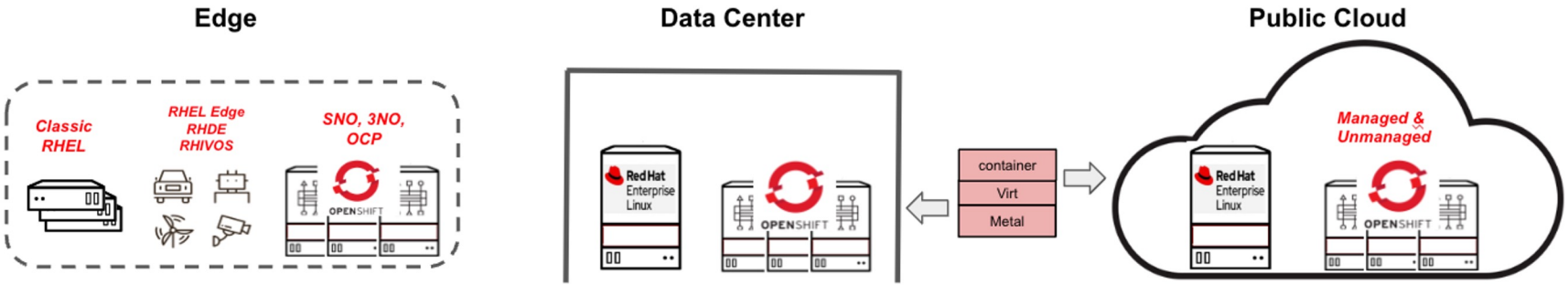

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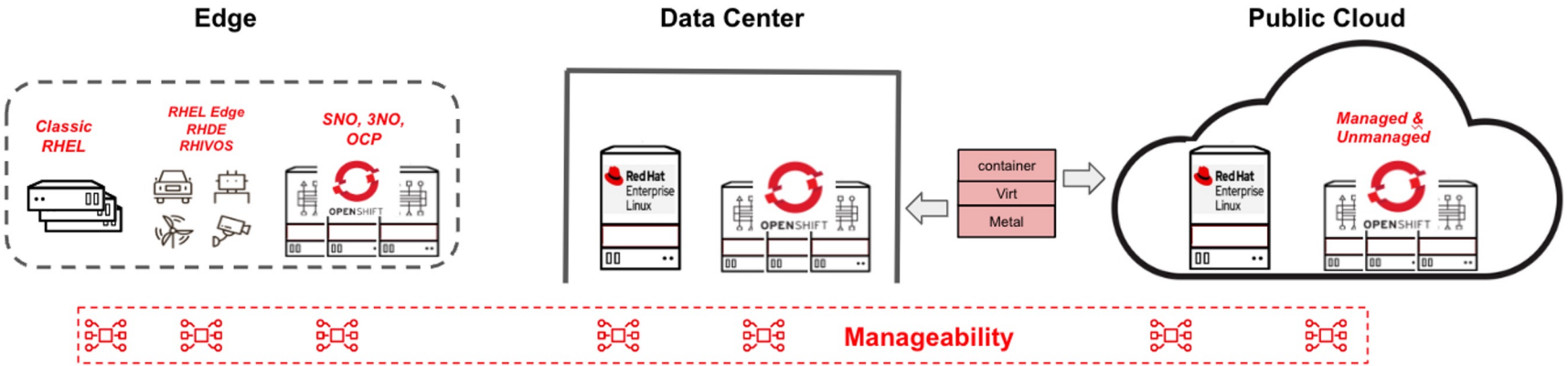

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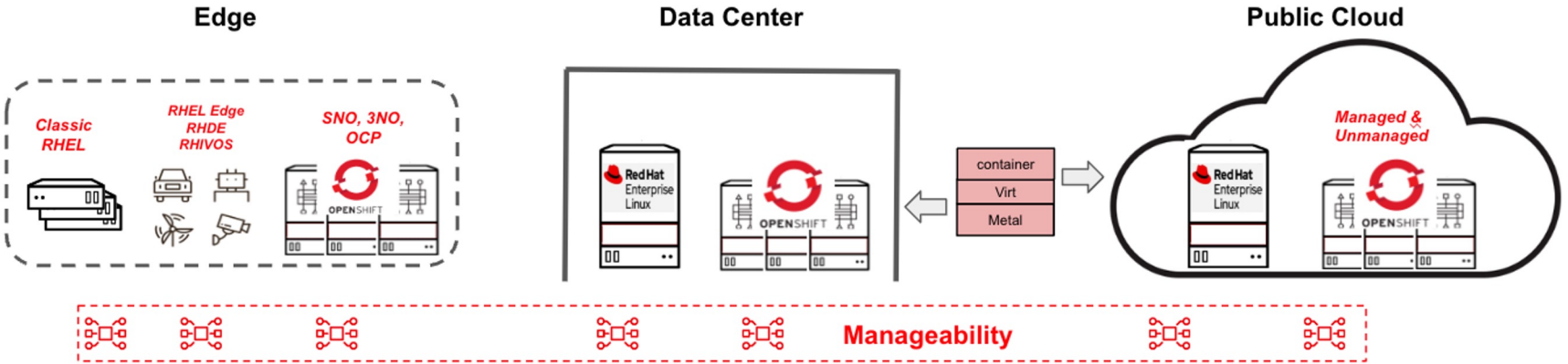


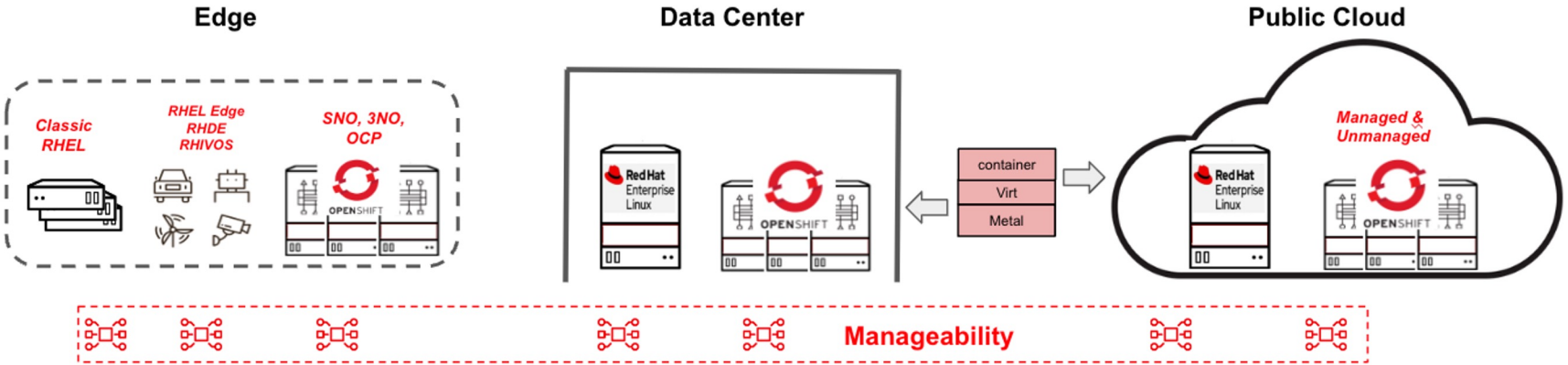
Management Capabilities

Lifecycle	Inventory	Configuration	Security	Automation	Continuity	Observability	Cost

Integration / Ecosystem

Operations
(IT Operators, Infrastructure Engineers, SREs, etc.)

Management Topology - Hybrid Infrastructure & Hybrid Cloud



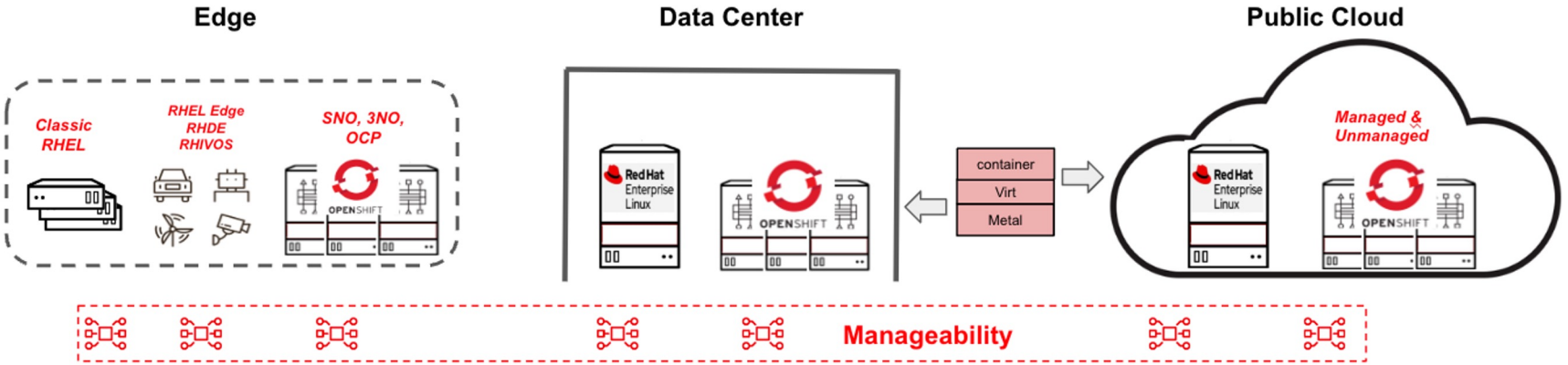
Management Capabilities

Lifecycle | Inventory | Configuration | Security | Automation | **Continuity** | Observability | Cost

Integration / Ecosystem

- Resilience
- Reliability
- Availability
- Supportability

Management Topology - Hybrid Infrastructure & Hybrid Cloud



Management Capabilities

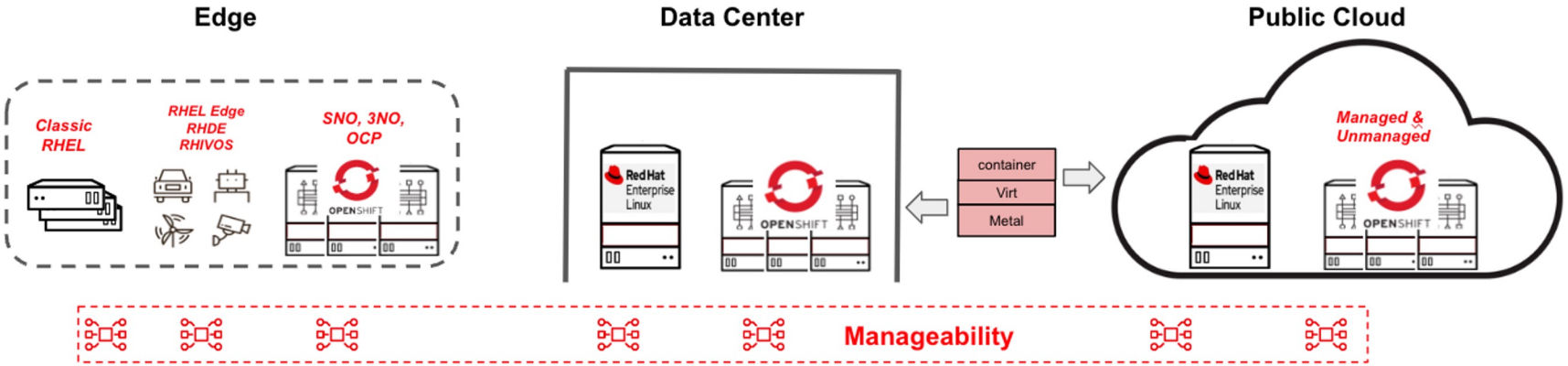
Integration / Ecosystem

Lifecycle | Inventory | Configuration | Security | Automation | **Continuity** | Observability | Cost

- Resilience
- Reliability
- Availability
- Supportability

Efficiency & Productivity

Security



Management Capabilities

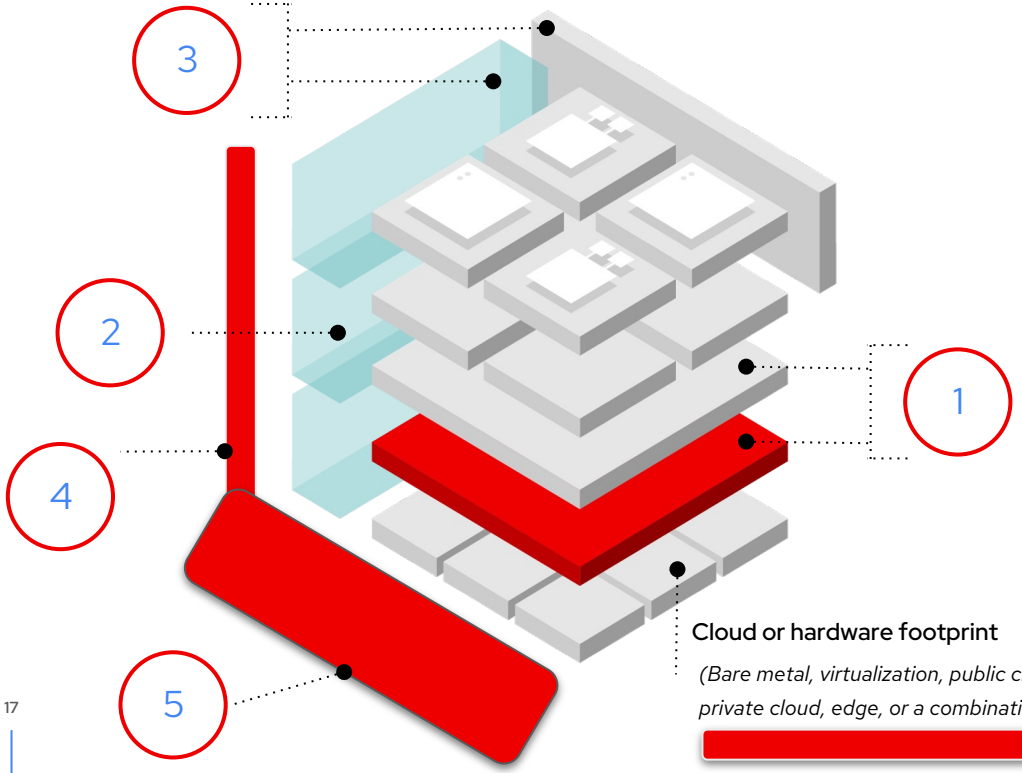
Integration / Ecosystem

Lifecycle | Inventory | Configuration | **Security** | Automation | Continuity | Observability | Cost

- Governance
- Risk
- Evidence
- Control

Security

Think of a layered approach for e2e security



1. Strong, complete foundation
2. Trusted software supply chain
   DevSecOps practices
3. App-Dev Enablement
4. Manage, automate, secure, compliant
5. Reduce Cost and time, increase confidence in : Gov, Risk & Compliance
6. Confidential Computing

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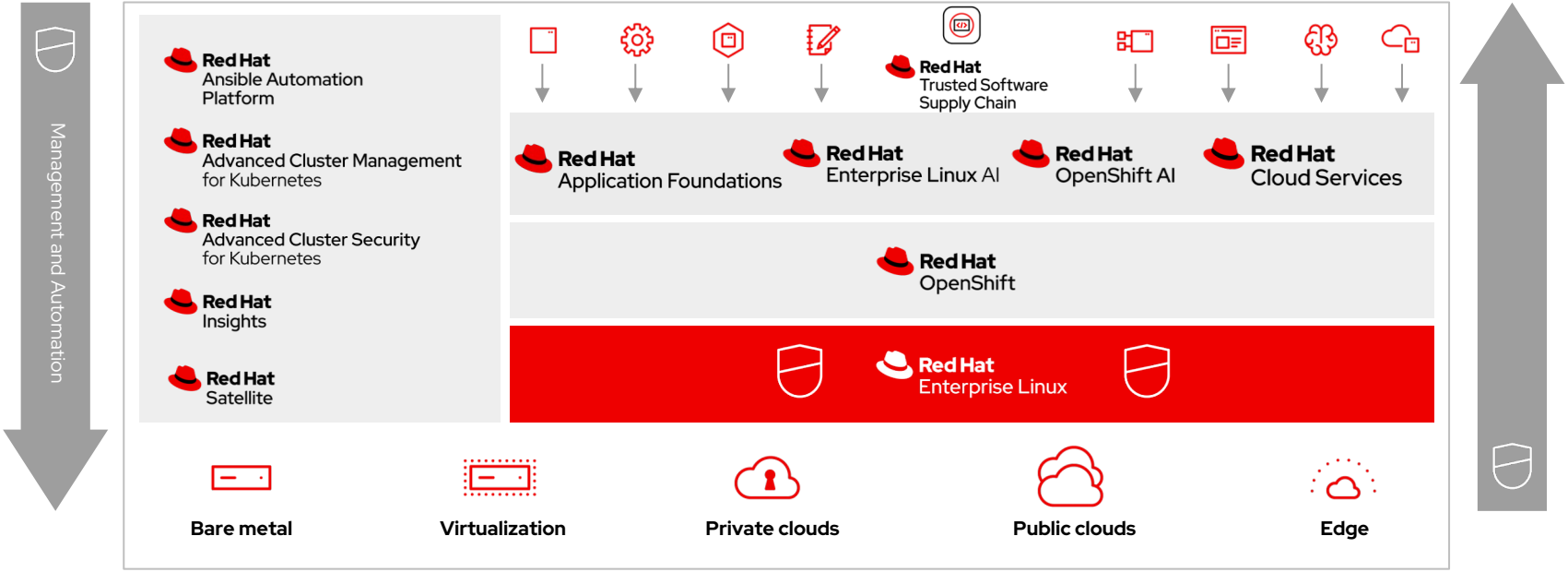
Layered security throughout the stack and lifecycle

Build, deploy, and run applications on top of a hybrid cloud using DevSecOps practices



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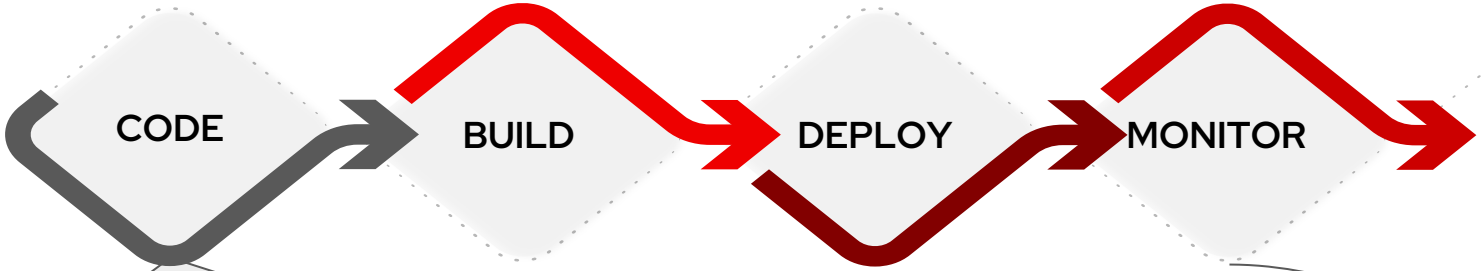
Application Lifecycle & Risk

Idea → Build → Deliver → Run → Govern



September 8, 2025 - 18 widely used npm packages - malicious code check-in using hacked maintainer account, ***2.6 billion downloads each week since 9/8/25***

Traditional Industry Focus

Year 2000 → 1000 CVE's → Year 2023 → 29000 CVE's

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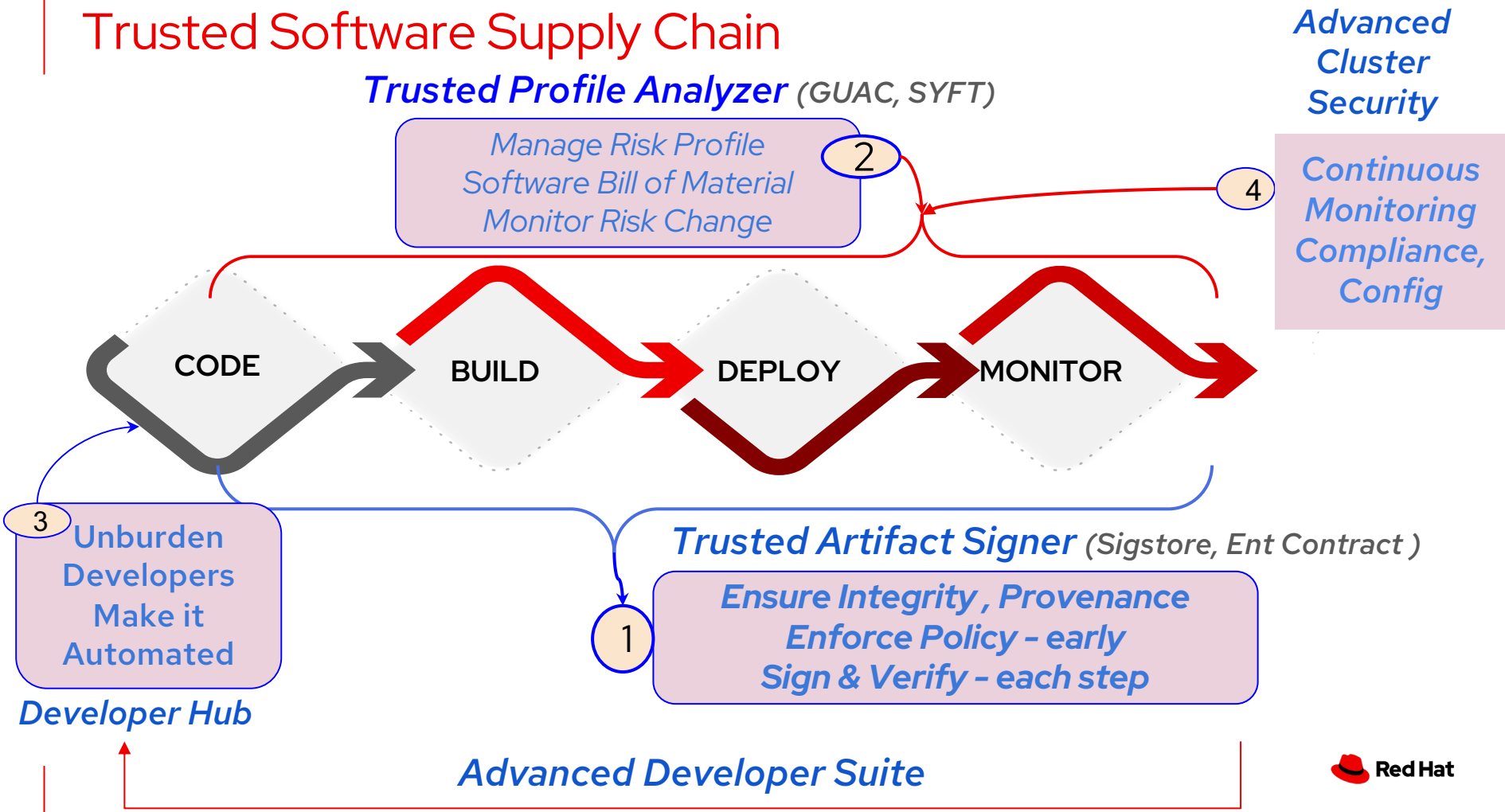
Trusted Software Supply Chain



Trusted Software Supply Chain

End to End Security Guardrails

CODE	BUILD	RELEASE	DEPLOY	MONITOR
Dependency Analytics	Reproducible Builds	SLSA Policy	Security Policy	Runtime
CVE & License	SBOM create and capture	Enforcement	Enforcement	Ongoing Registry
Policy Enforcement	Vulnerability Scanning	Signing Released	Signature Verification	Scanning
Sign & Verify	Provence Metadata	Artifact	(admission controller)	SBOM Analysis
	Signing & Attestation			

RH Trusted Profile Analyzer

RH Trusted Artifact Signer

RH Advanced Developer Suite

RH Advanced Cluster Security

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Trusted Software Supply Chain - (

Trusted Content

Application Libraries

Language Runtime

Universal Base Image

Provenance, Attestation of Curated Content

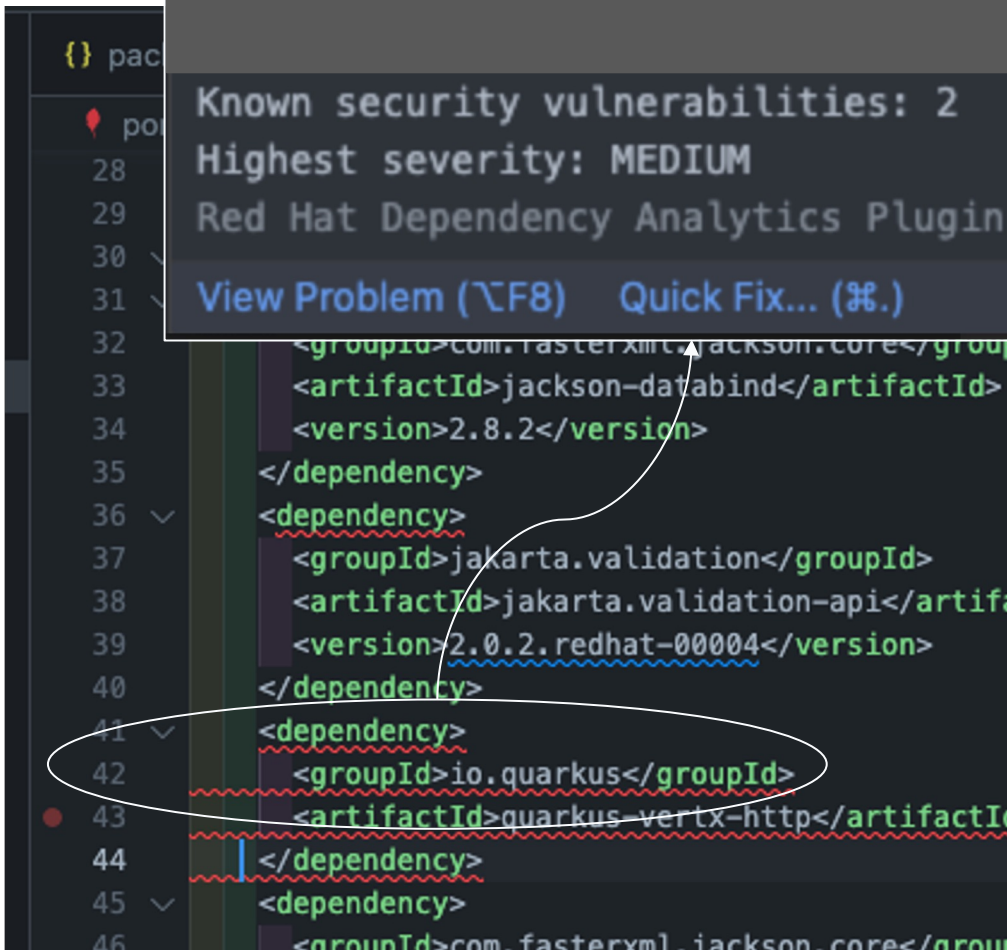
CODE

Dependency Analytics

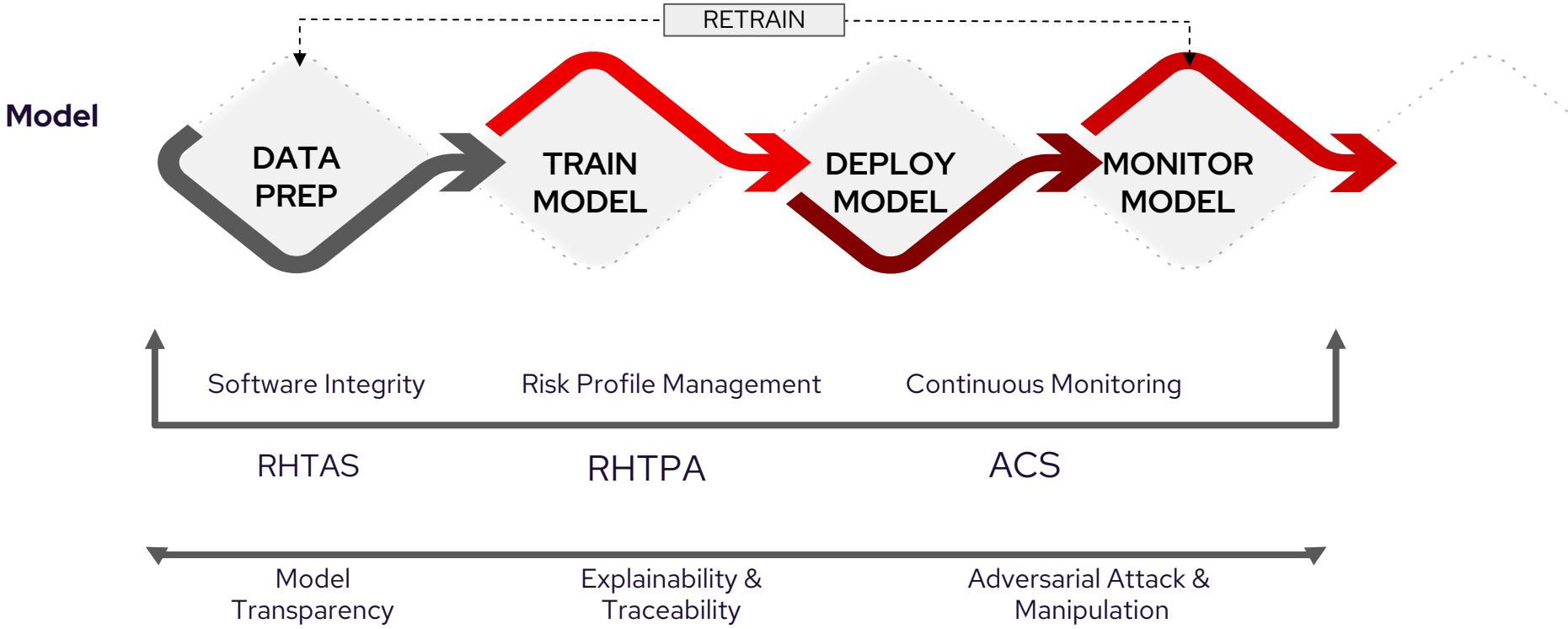
CVE & License

Policy Enforcement

Sign & Verify



Model Development Lifecycle



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AI Safety & Security - GenAI

Security

Defending from malicious actors and adversaries

- Software Integrity - Tampering, modifications, Provenance, Data Lineage
- Risk Profile - Vulnerability & License, Malicious Pkg
- AI SBOM Trusted Content/Models
- Model stealing, Poisoning (prompt, data)

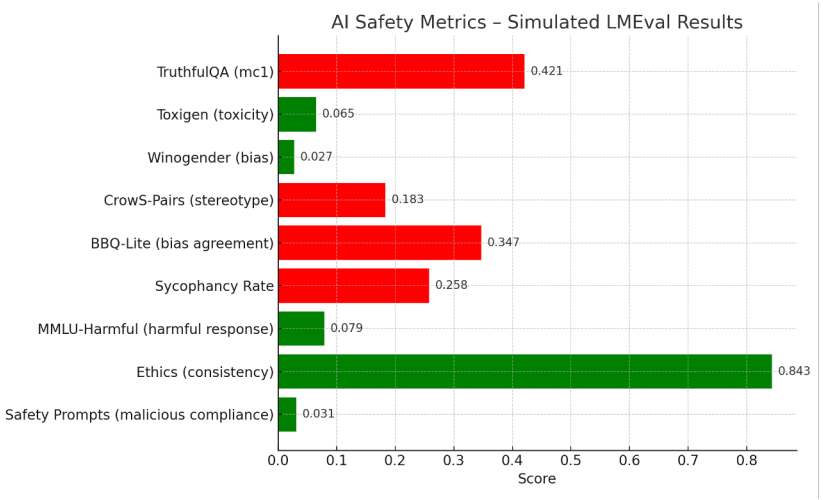
Safety

Preventing AI from causing unintentional harm

- Correctness & unintended behaviour
- Bias and Fairness
- Hateful Contents
- Explainability & Interpretability
- Hallucination/Misinformation
- PII, Data, System leakage

TrustyAI – LLM Eval : Model quality & explainability

AI Safety Context: **truthfulness**, **toxicity**, **bias**, and **reasoning errors**



Metric Descriptions:
- *TruthfulQA: Measures factual accuracy.*
- *Toxigen: Scores model's tendency to produce toxic content.*
- *Winogender: Tests gender bias in pronoun resolution.*
- *CrowS-Pairs: Evaluates stereotypical bias.*
- *BBQ-Lite: Tests agreement with biased assumptions.*
- *Sycophancy Rate: Measures blind agreement with user statements.*
- *MMLU-Harmful: Detects harmful content in multiple-choice responses.*
- *Ethics: Assesses alignment with ethical decisions.*
- *Safety Prompts: Checks for compliance with malicious instructions.*

- lm-eval --model gpt2 --tasks truthfulqa_mc,winogender,toxigen,sycophancy_qa

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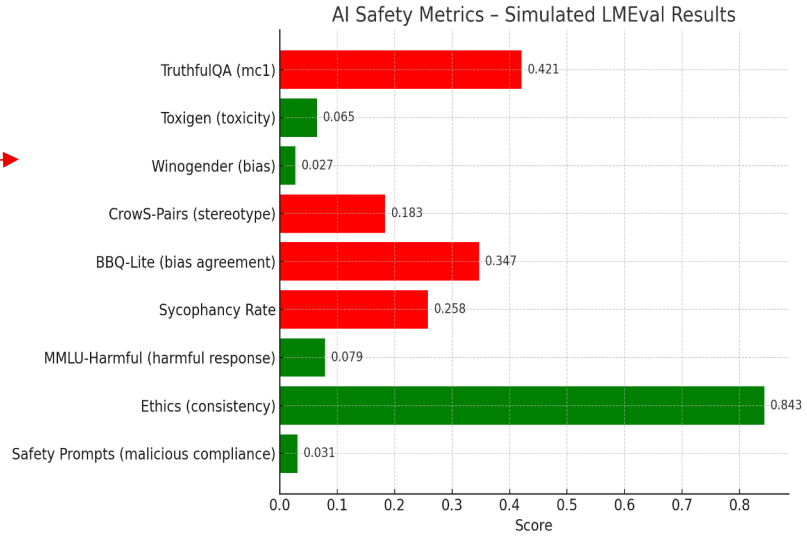
Red Hat Trusted Profile Analyzer- Dependency Analytics

llama-stack-tutorial / 1-models-add.py

Code | Blame | 35 lines (26 loc) · 886 Bytes

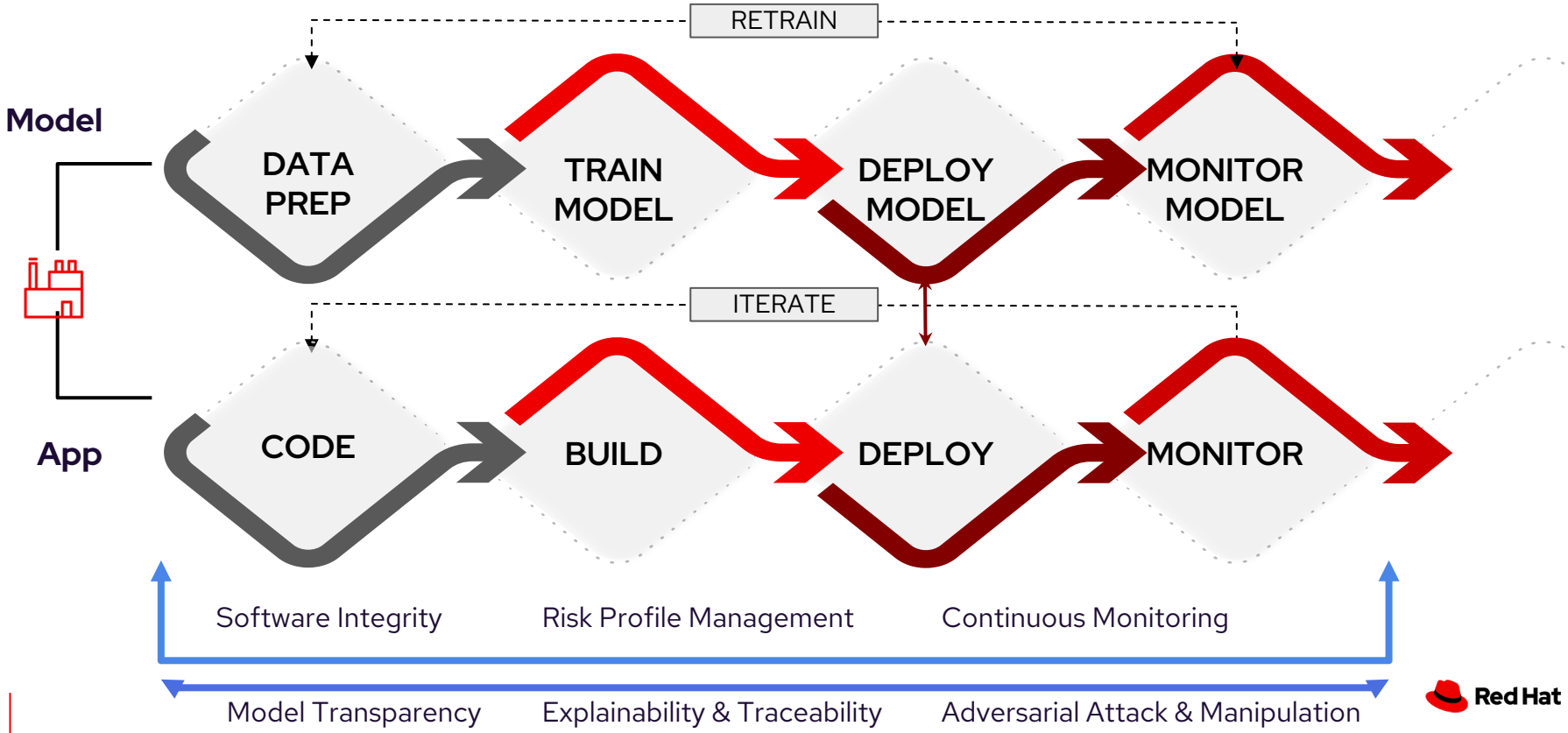
```
8
9   # Configure logging
10  logging.basicConfig(
11      level=logging.INFO,
12      format="%(asctime)s - %(levelname)s - %(message)s",
13      datefmt="%Y-%m-%d %H:%M:%S",
14  )
15  logger = logging.getLogger(__name__)
16
17  LLAMA_STACK_SERVER=os.getenv("LLAMA_STACK_SERVER")
18
19  from llama_stack_client import LlamaStackClient
20  client = LlamaStackClient(base_url=LLAMA_STACK_SERVER)
21  # from llama_stack import LlamaStackAsLibraryClient
22  # client = LlamaStackAsLibraryClient("ollama")
23  # client.initialize()
24
25
26  # Make sure to `ollama run llama3.1:8b-instruct-fp16 --keepalive 60m`
27
28  # Register a model
29  model = client.models.register(
30      model_id="meta-llama/Llama-3.1-8B-Instruct",
31      model_type="llm",
32      provider_id="ollama",
33      provider_model_id="llama3.1:8b-instruct-fp16",
34      metadata={"description": "llama3.1:8b-instruct-fp16 via ollama"}
35  )
```



Recommendation : Add **Output Shields Guardrails**

Content moderation (e.g., Detoxify, Perspective API): Toxicity, hate speech
Bias detection layers (CrowS-Pairs, Winogender): Gender, racial, religious bias
Ethical correctness modules: Unethical or harmful outputs

Software Development Life cycle with Model Development Lifecycle



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Confidential Computing

Existing Encryption

Data At Rest

Data Encryption and System Attestation

- Protect Data on Disk using LUKS and Network Bound Disk Encryption (NBDE)
- Attest system state on boot, ensuring that system packages have not been compromised with IMA and Keylime
- Attest container workloads with Key Brokering Service (KBS)
- Ensure data remains unreachable in case of unauthorized access to the storage

Data In Motion

Encrypt Traffic Leveraging Strong, Future Proof Cryptography

- Protect data moving through the environment using strong, smart and validated cryptography
- Centralized management and establishment of secured connections native part of workflow for Red Hat Platform
- Automation provided allows consistent deployment and security configuration

New

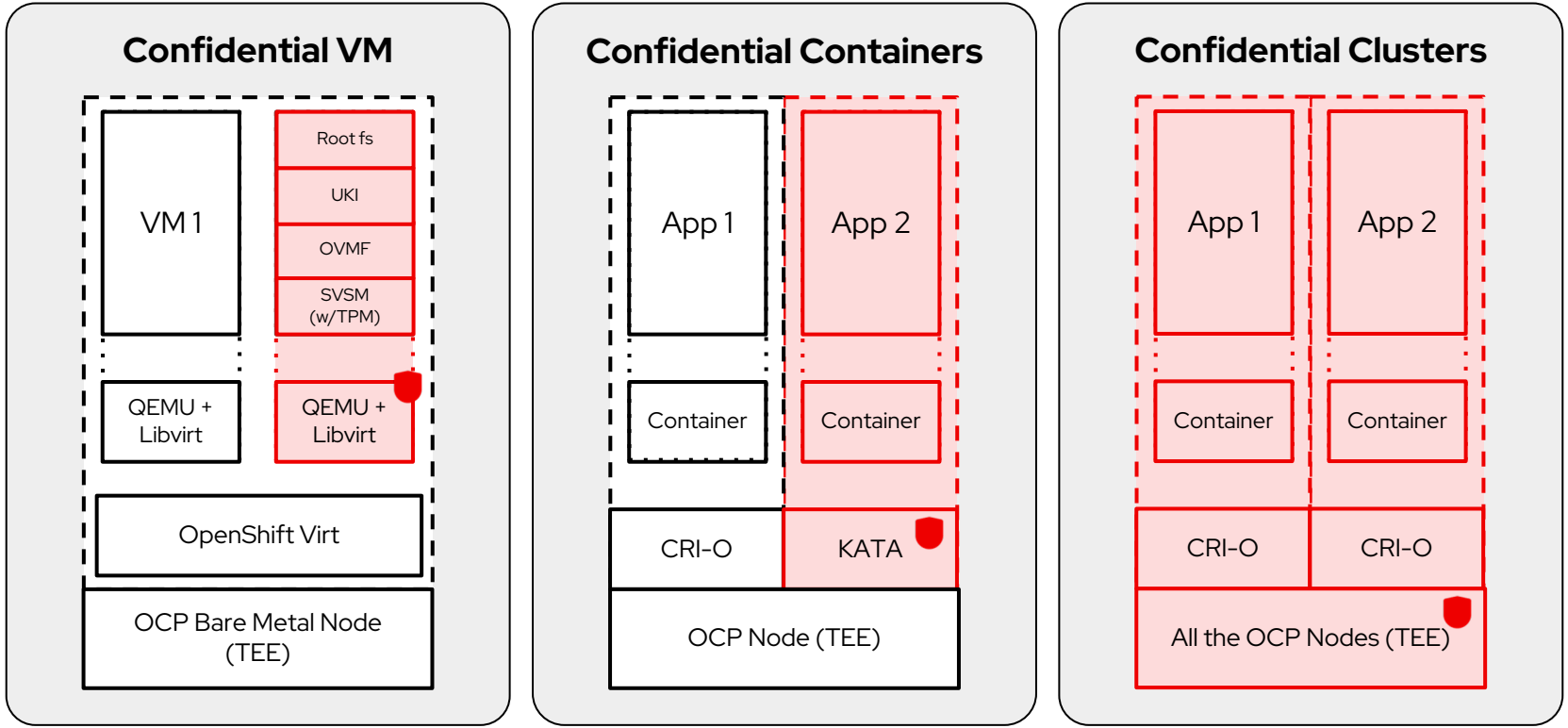
Data In Use

Confidential Computing Use Trusted Execution Environment Capabilities

- Protect data and workloads in use with Trusted Execution Environments as Confidential Computing is enabled on the major hardware platforms for AMD, Intel and NVIDIA
- Leverage these Trusted Execution Environments on prem or in the major cloud platforms
- Increases the security level of organizations that manage sensitive and regulated data

https://confidentialcomputing.io/wp-content/uploads/sites/10/2023/03/CCC_outreach_whitepaper_updated_November_2022.pdf

Trust Boundaries



Customer

Confidential context - *Guest Owner*

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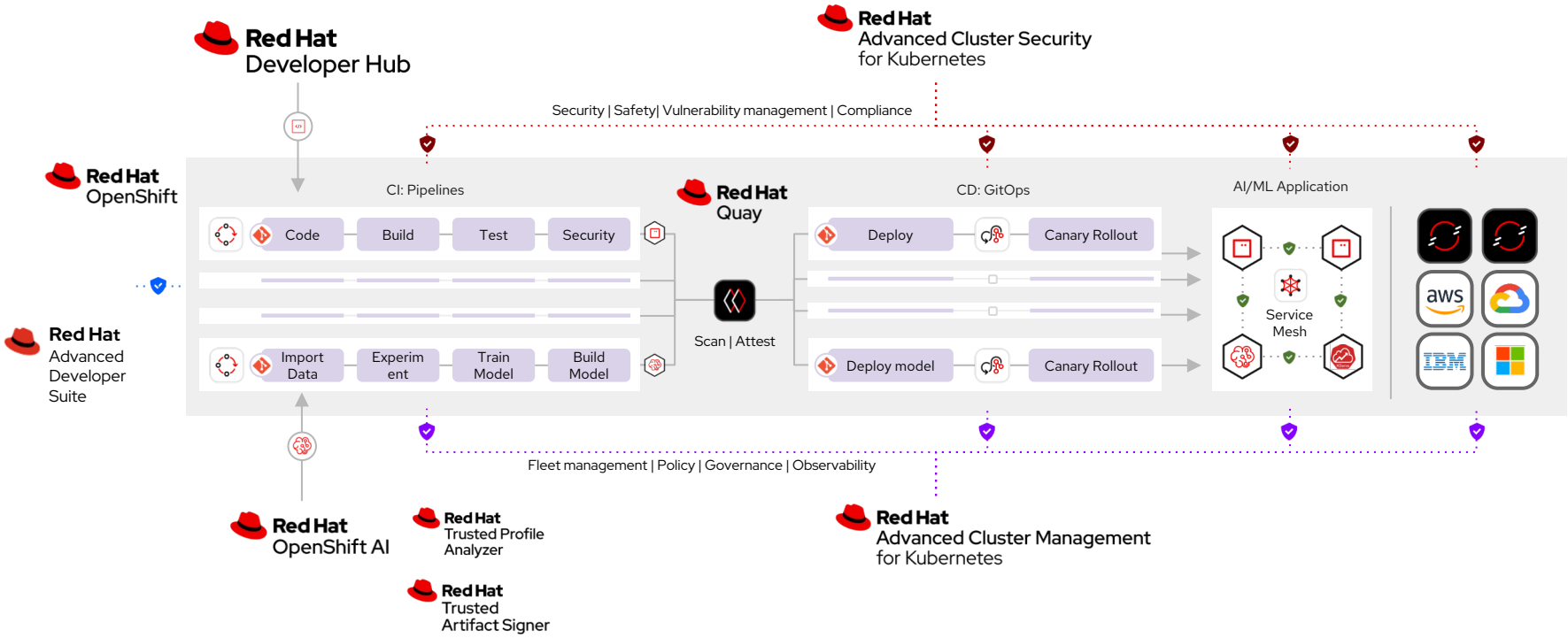
Trusted Software
Supply Chain

Securely build, deploy, run applications at scale



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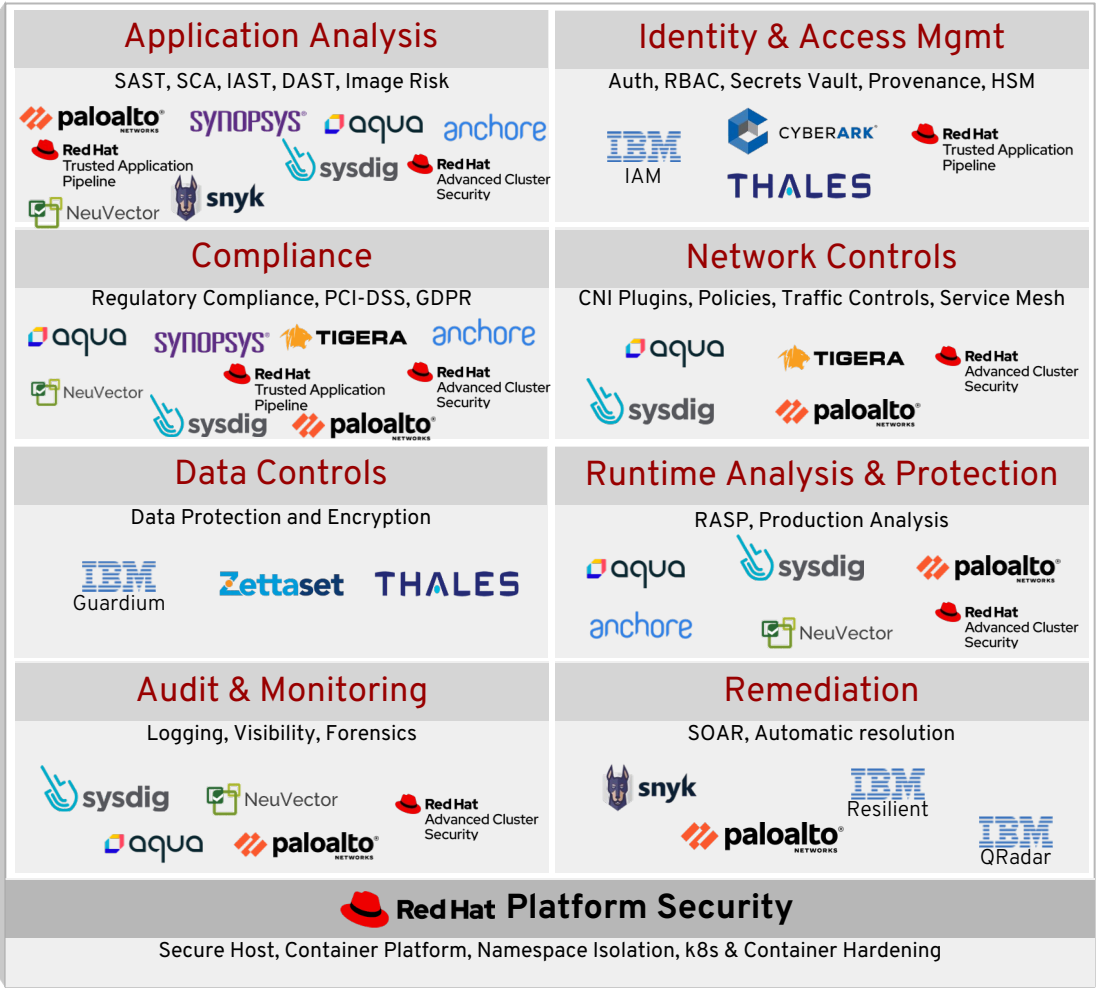
The Security Ecosystem

Partner Ecosystem extends and enhances Red Hat functionality

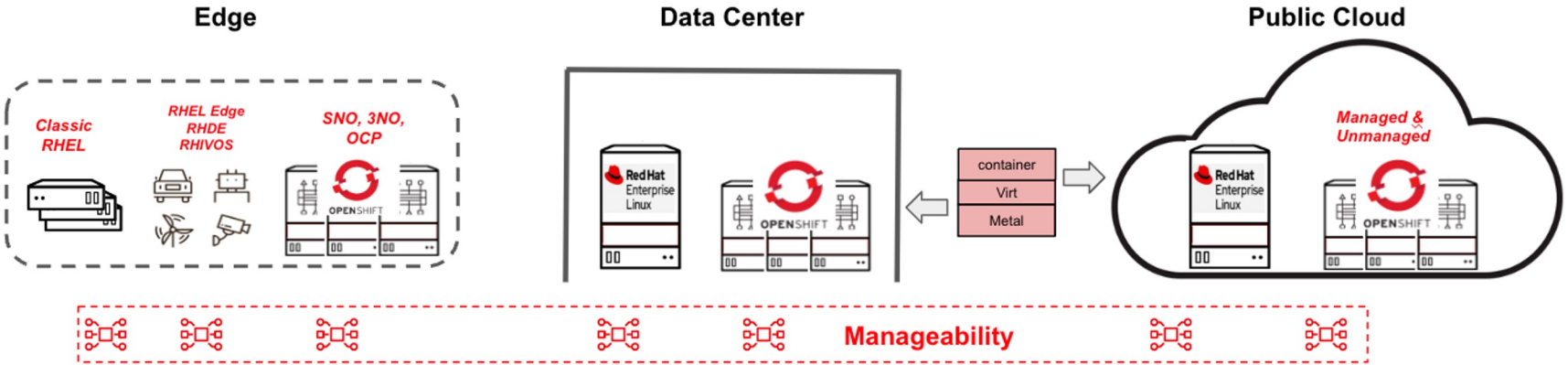
Easily add capability with IDE Plug-ins

Provide Developers a single interface with built-in security guardrails



Let’s draw a picture

Trust and Resilience in Modern Sovereign Infrastructure



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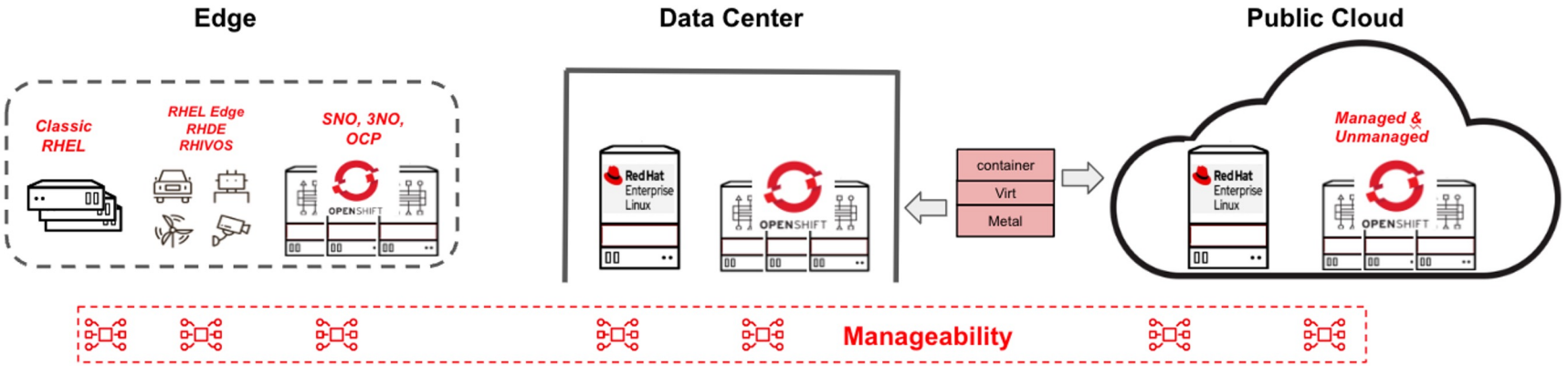

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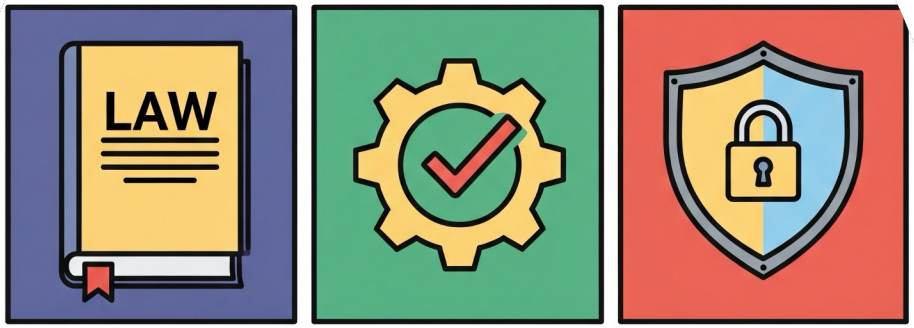

Regs, Comp, Sec

- Regulation sets the rules and requirements to be followed.
- Compliance ensures adherence to established regulations and policies.
- Security focuses on protecting systems and data from threats.
- Overlap exists as security posture often support compliance.

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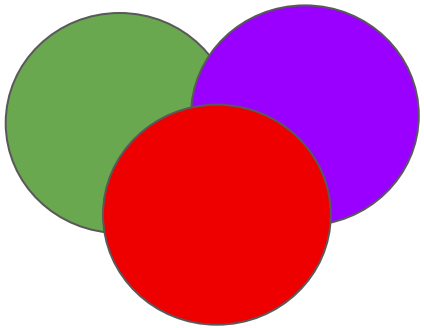
GRC is the driving force

Governance provides strategic oversight and direction.

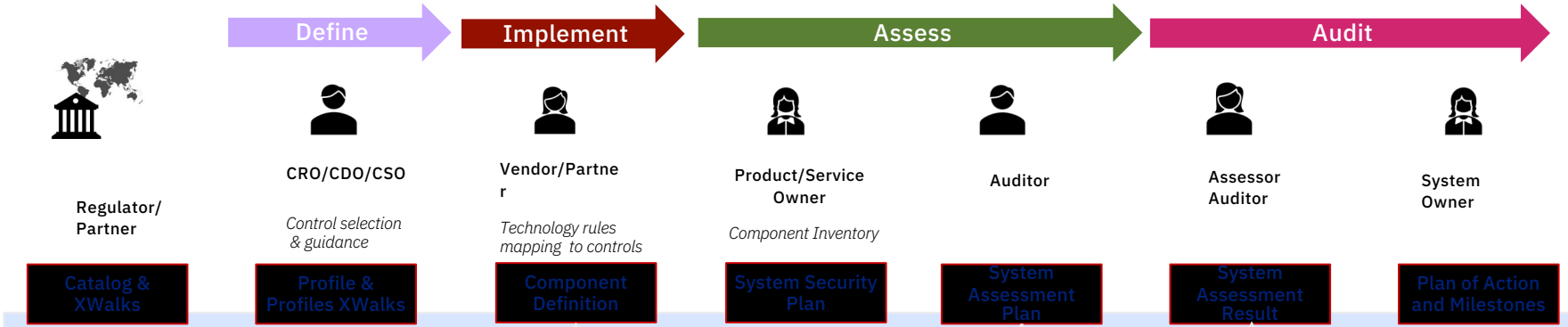


Risk management identifies and enables mitigations for potential threats.

Compliance ensures adherence to rules and regulations.

Regulatory Compliance : Data / Process flow

Enhancing management tooling and integration patterns, enables reduction in friction for e2e posture delivery



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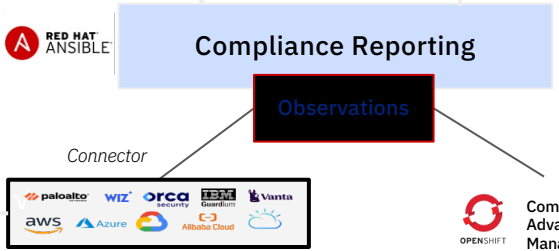

OPENSHIFT

Compliance Operator
Advanced Cluster Management
Advanced Cluster S

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Regulatory Compliance : Data / Process flow

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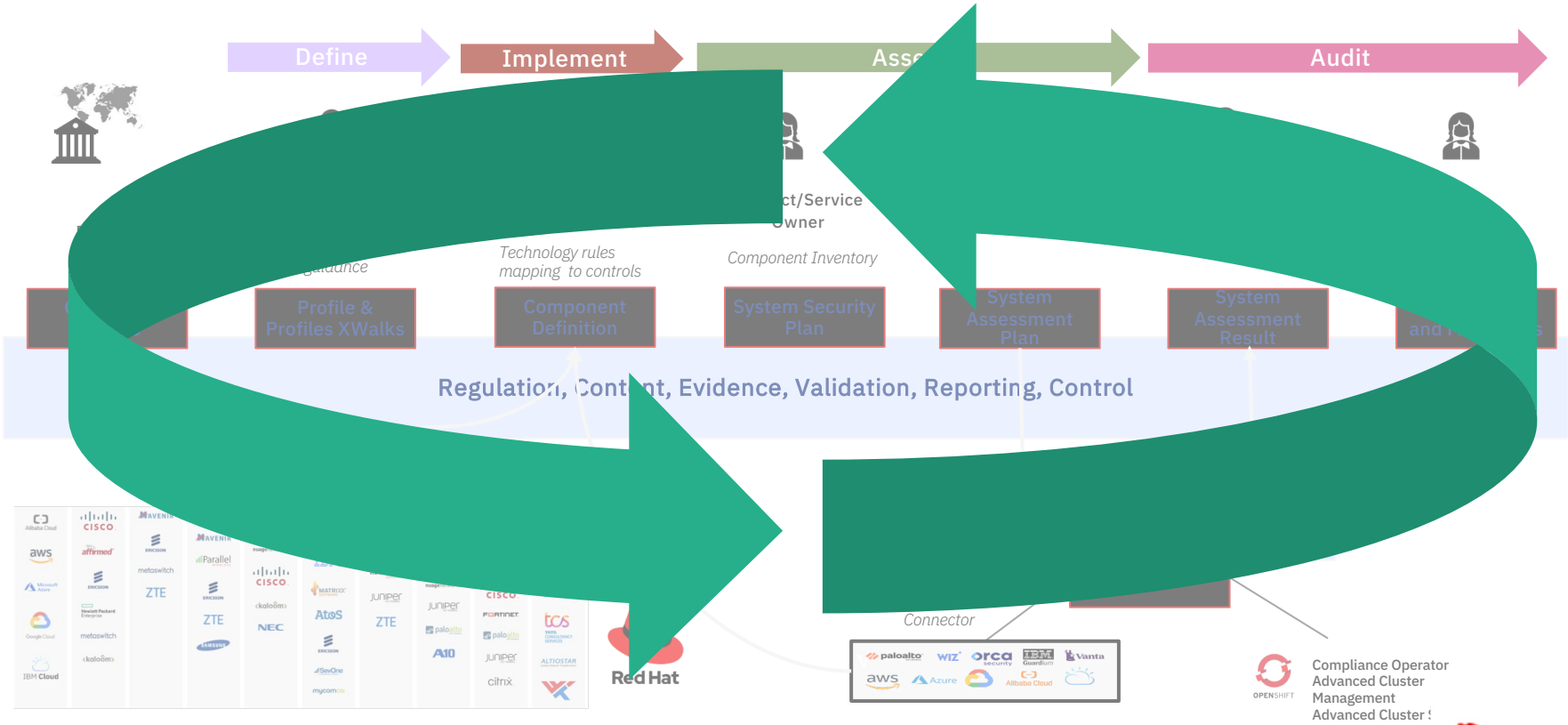

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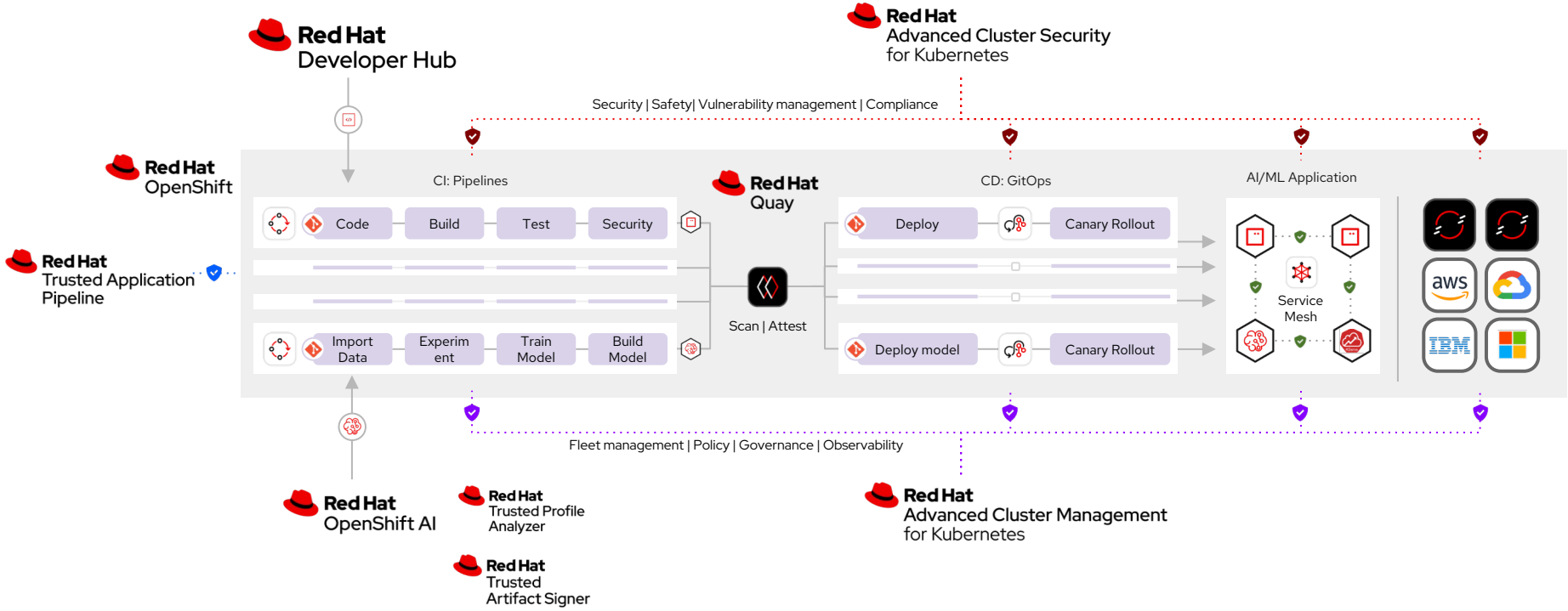
Two types of regulation controls

Process

Qualified

Build, deploy & run at scale



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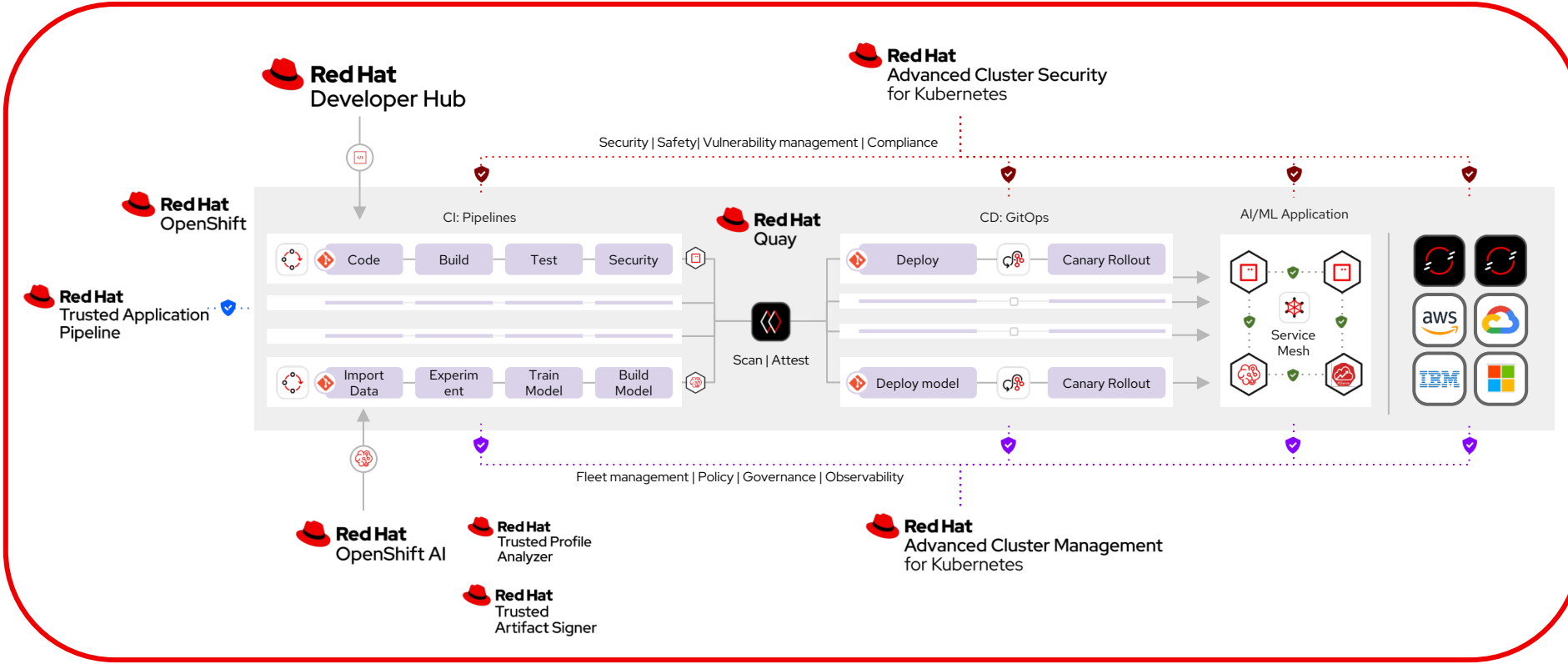
Build, deploy & run at scale : in Boundary



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EU Digital Operational Resiliency Act (EU-DORA)

Promoting the economic sovereignty of the EU by protecting its financial sector from external threats

- **Risk Management** [1] → Detection, recovery, business continuity policies and disaster recovery plans
- **Incident Management**[2] **and Intelligence sharing** [5] → NIS Directive, cybersecurity & (harmonised) reporting
- **Digital Operational Resilience Testing** [3] → Concentration risk analysis, pen testing including remediation plans
- **ICT third-party risk** [4] → Critical ICT 3rd parties subject to an EU oversight framework
  - amazon web services
  - Microsoft Azure
  - Google Cloud
  - IBM Cloud
- **Exit-Strategy** [6]

"Consolidate and upgrade ICT (information and communications technology) risk requirements across the financial entities to ensure all are subject to a common set of standards to mitigate ICT risks."

Source: DORA Proposal: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=COM:2020:595:FIN&rid=1

(1) Section II- art 5-14
(2) Section III- art 15-20
(3) Section IV- art 21-24
(4) Section V- art 25-39
(5) Section VI- art 40
(6) Section V- art 25-27

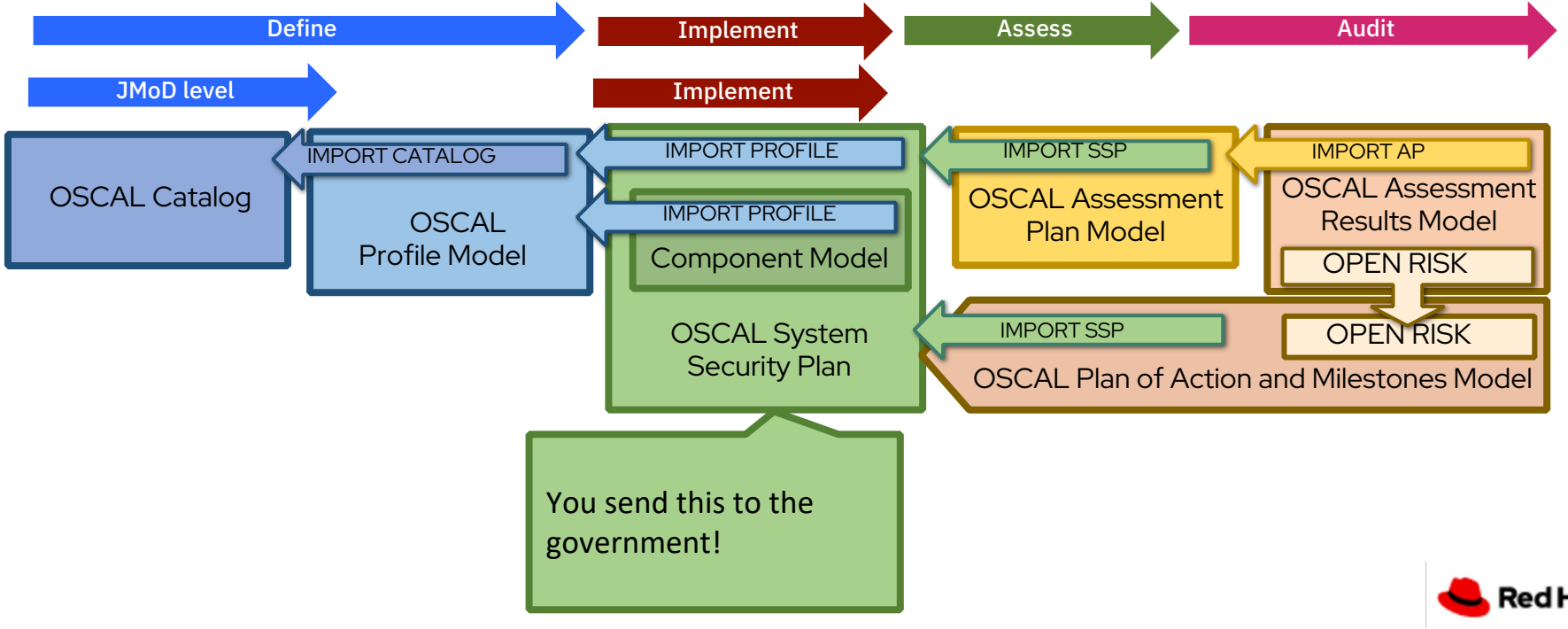
NIST 800 53 : Security and Privacy Controls for Information Systems and Organisations

- **AC**: Access Control
- **AT**: Awareness and Training
- **AU:** Audit And Accountability
- **CM**: Configuration Management
- **CP**: Contingency Planning
- **AI**: Identification and Authentication
- **IR**: Incident Response
- **MA**: Maintenance
- **MP**: Media Protection
- **PS**: Personnel Security
- **PT**: PII Processing and Transparency
- **PE**: Physical and Environmental Protection
- **PL**: Planning
- **PM**: Program Management
- **RA**: Risk Assessment
- **CA**: Security Assessment and Authorization
- **SC**: System and Communications Protection
- **SI**: System and Information Integrity
- **SA**: System and services acquisition
- **SCRM**: Supply Chain Risk Management

Definition at https://github.com/usnistgov/oscal-content/tree/main/nist.gov/SP800-53

OSCAL Makes It Manageable

OSCAL provides a higher level data models designed for cloud compliance



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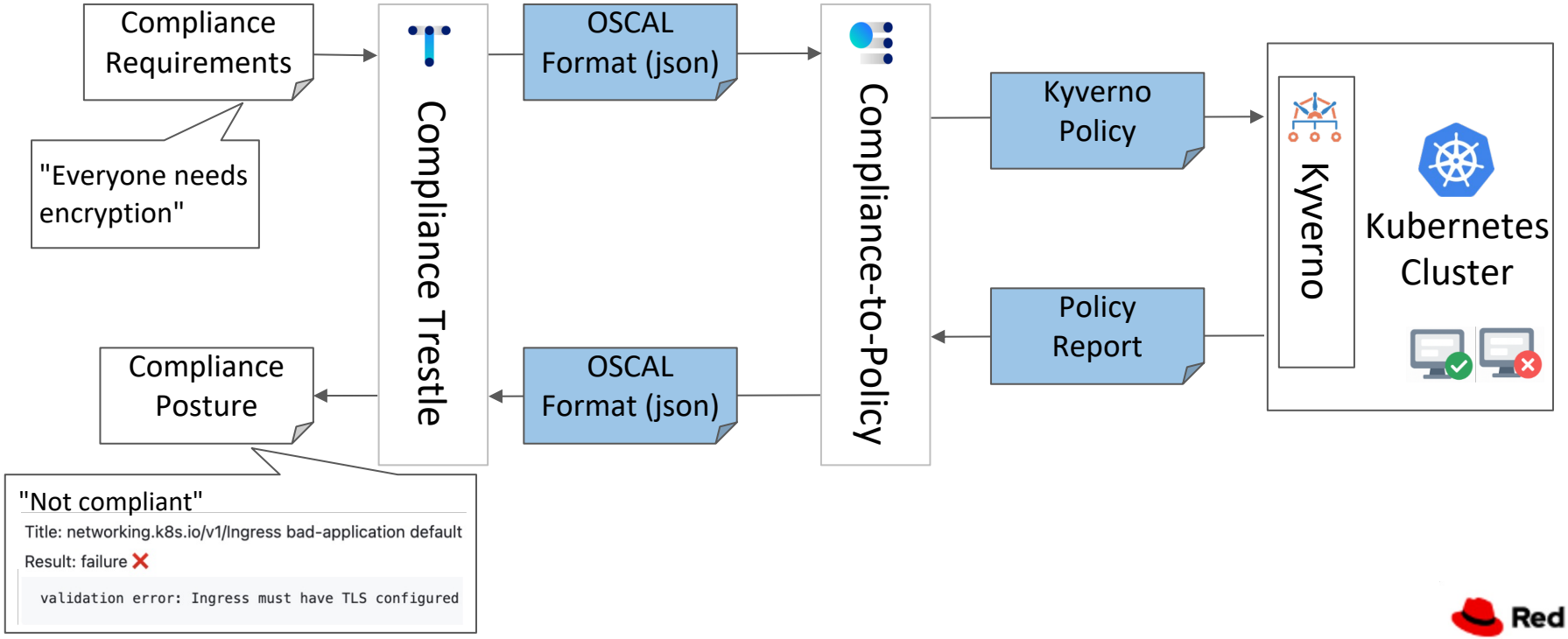
From Compliance Requirement to Policy Enforcement

Handle bidirectional conversion between human-readable formats and OSCAL

Bridge OSCAL and actual enforcement (Kyverno), and feeds the result back into OSCAL.



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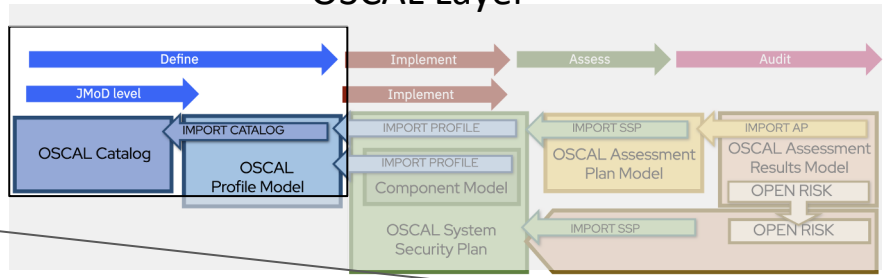
NIST 800-53 Catalog for Encryption Control

OSCAL Layer




```
{
 "id": "sc-13",
 "class": "SP800-53",
 "title": "Cryptographic Protection",
 "params": [{
     "id": "sc-13_prm_1",
     "label": "organization-defined cryptographic uses"
   },{
     "id": "sc-13_prm_2",
     "label": "organization-defined types of cryptography for each specified cryptographic use"
   }],
 "parts": [{
   "id": "sc-13_smt",
   "name": "statement",
   "parts": [{
       "id": "sc-13_smt.a",
       "name": "
       "props":
           "name
           "valu
         }],
       "prose":
     },{
       "id": "sc
       "name": "
       "props":
           "name
           "value
         }],
       "prose": "Implement the following types of cryptography required for each specified cryptographic use: {{ insert: param, sc-13_prm_2 }}.
       "
     }]
   },{
     "id": "sc-13_gdn",
     "name": "guidance",
     "prose": "Cryptography c
     controlled unclassified
     separation when authoriz
     also be used to support
     cryptography and NSA-app
     NSA-approved cryptograph
     cryptography. Cryptograp
     standards, and guidelines."
   }]
}
```



```
"id": "sc-13",
"class": "SP800-53",
"title": "Cryptographic Protection",
```



```
"prose": "Implement the following types of cryptography required for each specified cryptographic use: {{ insert: param, sc-13_prm_2 }}."
```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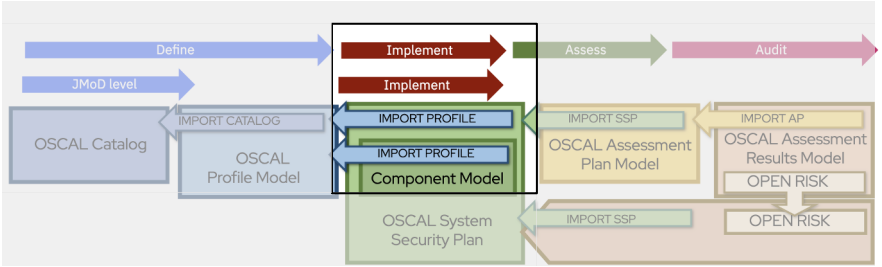
Implementation of Enforcement Policy

Here is the Kyverno Policy to enforce TLS configuration on Ingress

```yaml
apiVersion: kyverno.io/v1
kind: ClusterPolicy
metadata:
  name: enforce-tls-on-ingress
spec:
  validationFailureAction: Enforce
  background: true
  rules:
    - name: require-tls
      match:
        resources:
          kinds:
            - Ingress
      mutate:
        patchStrategicMerge:
          metadata:
            annotations:
              nginx.ingress.kubernetes.io/force-ssl-redirect: "true"
          spec:
            tls:
              - secretName: my-cert
```

OSCAL Layer



Target is Ingress

```yaml
match:
  resources:
    kinds:
      - Ingress
```

Mutating annotation and tls secret field

```yaml
patchStrategicMerge:
  metadata:
    annotations:
      nginx.ingress.kubernetes.
      io/force-ssl-redirect:
      "true"
  spec:
    tls:
      - secretName: my-cert
```

EU cyber resilience Act

December 10, 2024

- Secure by design
- Enforced Lifecycle
- Clear, complete Vulnerability Mgmt
- Deliver use-case models
- Compliance ready
- Transparency in origin : SBOM
- Enforced Ownership
- Assured Resilience

- Applies to everyone who has an interest in EU
- All content is in boundary
- Standards are required
- Build to intended use is now required

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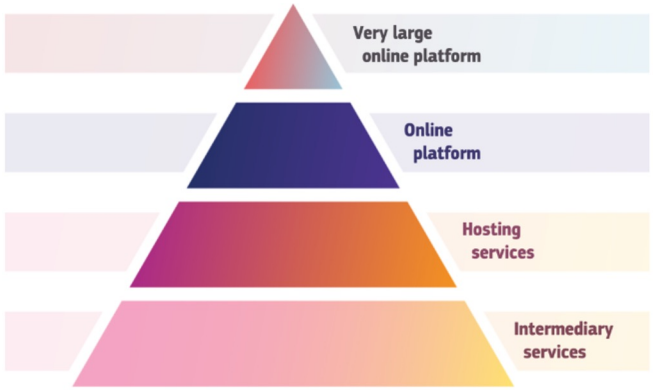
EU Digital Services Act

- Transparency : Process, Code, Content, Adverts
- Risk Assessment and Regulator Control
- 6% of the global revenue : Penalty



EU Network and Information Systems Directive 2

- Focused on cyber security for core infra
- Process focused : incident handling, network security etc
- Procedures for cryptography and encryption
- Enforces people centric context: eg Auth

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EU Cyber Solidarity Act

Q1 / 2025

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In Germany, the Product Liability Act (ProdHaftG) is being updated to explicitly include software as a product

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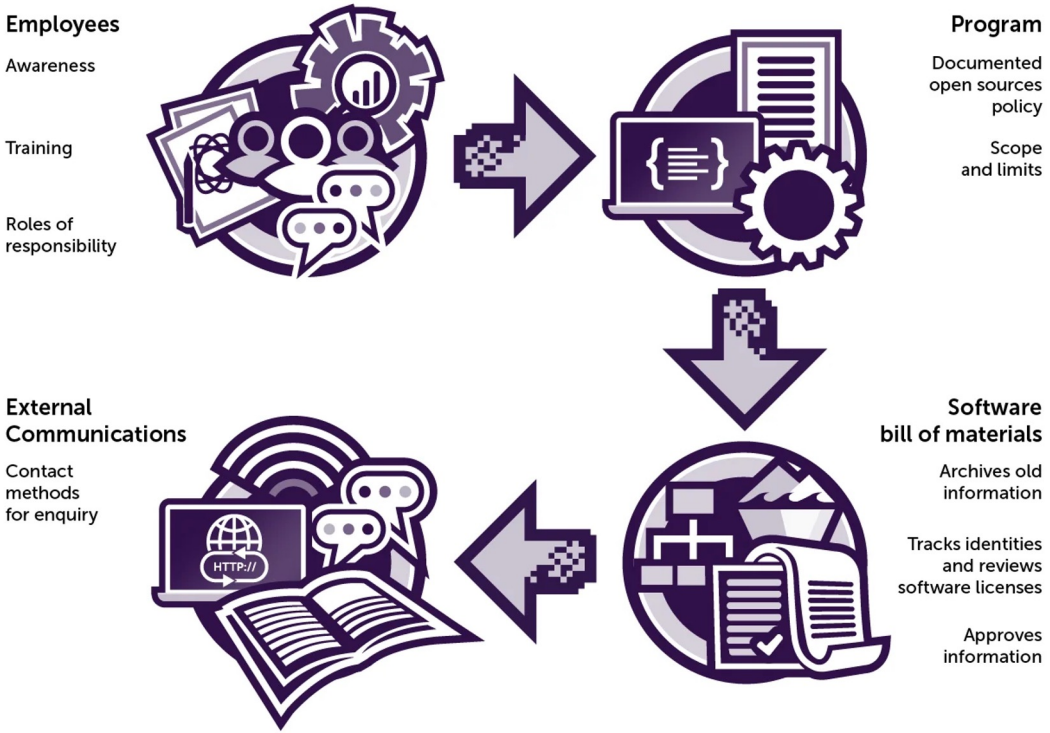
License Compliance is not a regulation context



The OpenChain project aims to formalise and deliver compliance program and tools for License focused Compliance posture

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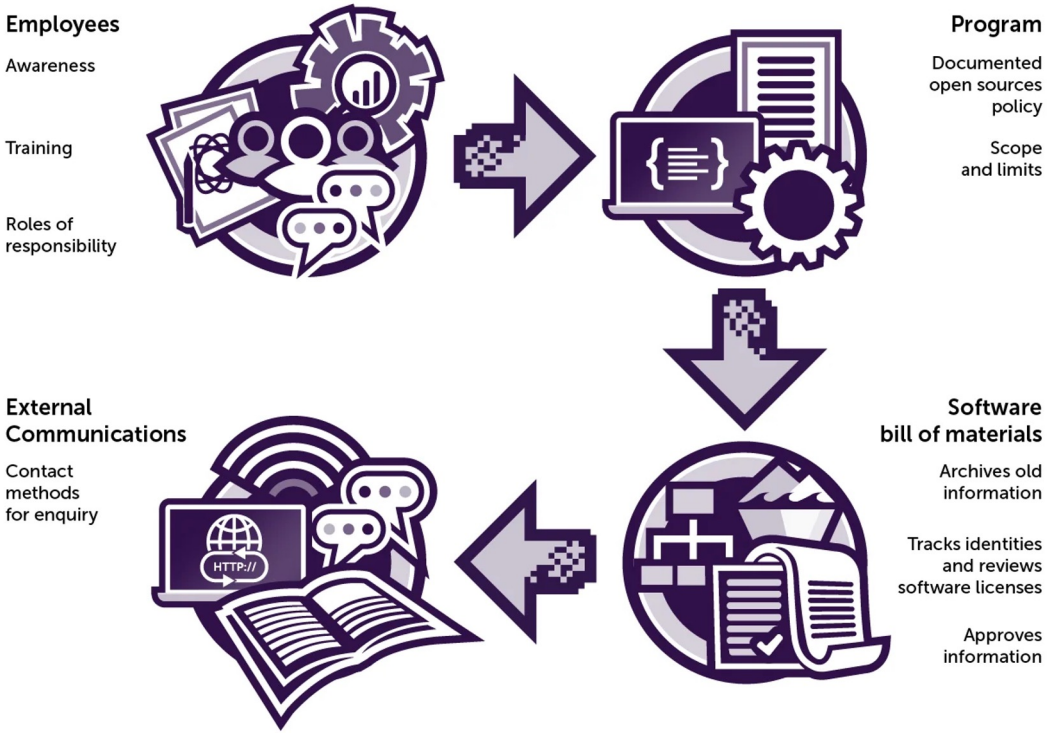
License Compliance is

regulation context



The OpenChain project aims to formalise and deliver compliance program and tools for License focused Compliance posture

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As an Open Source developer

- Safety is everyone's concern
- Security is everyone's concern
- Maintainability is a concern
- Evidence generation is key
- Provenance should be assured

- Data privacy is a challenge
- Vulnerability can have severe consequences
- Open can imply lower barrier for APT
- Transactions need confidence

Key Takeaways & Considerations

- Open source has a vital role in regulated environments.
- Safety and security start at inception
- Understanding regulations is crucial for developers.
- Evidence generation and provenance are key.
- Standards enable a rapidly maturing open source compliance tools .

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