# Holmes Processing

*Cyber Threat Intelligence at Scale*

# Who we are

George Webster

Technical University of Munich

## PhD Candidate

- Scalable Methods for Cyber Analytics
- Static and Dynamic Analysis
- Distributed Systems
- Over a Decade in Industry and Academia

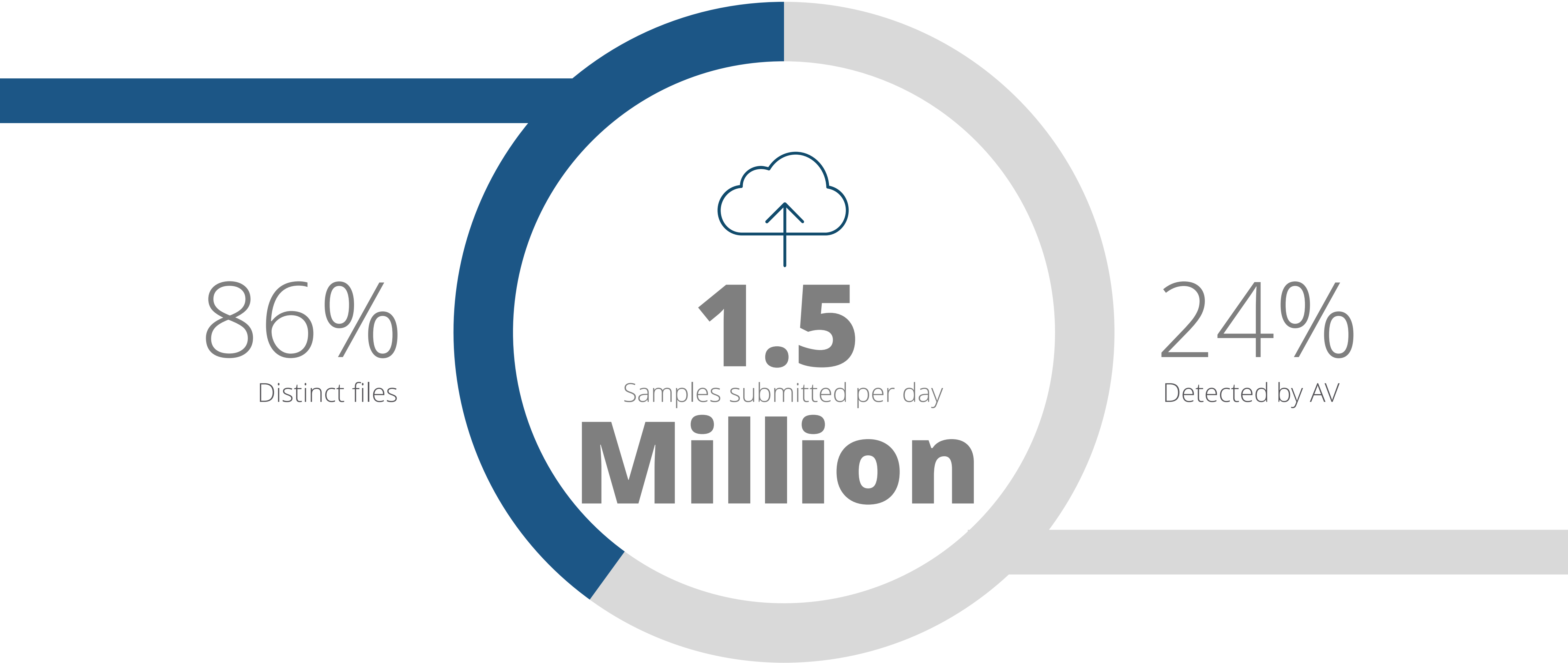
Christian von Pentz

Technical University of Munich

## Research Assistant

- Web Application Security
- Scalable Architecture Design
- Process Automation
- CTF player

# Problem



86%

Distinct files

1.5

Samples submitted per day

Million

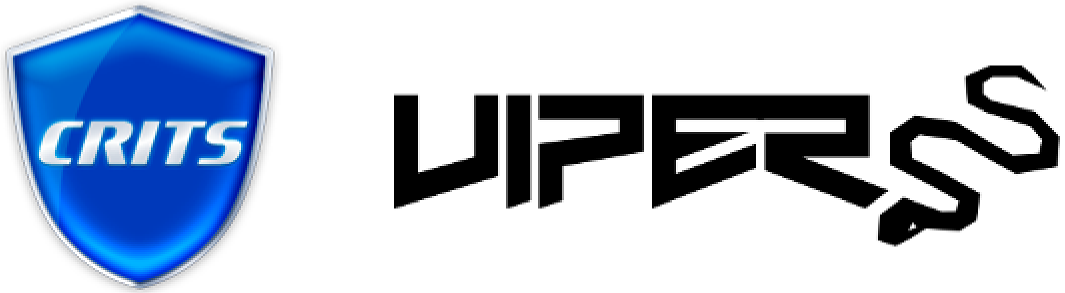
24%

Detected by AV

# Current Solutions

Great for what they were designed for but...

DO THEY SOLVE THE BIG PROBLEM?



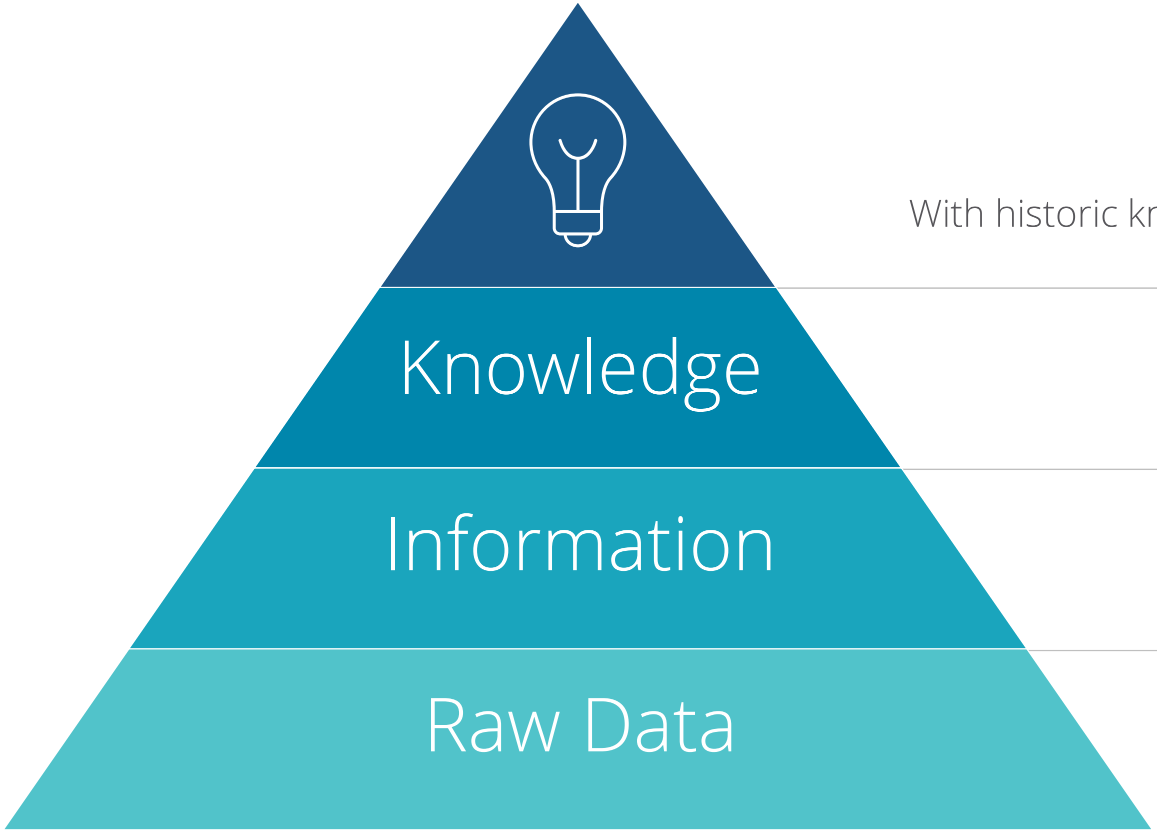
01 **Designed to solve one problem**
Most solutions are designed to get the job done for a single purpose

02 **...but they are disjointed**
Our tools are not designed to interact with each other

03 **Do not easily scale**
Often monolithic in design and focused on scaling with more powerful workstation

04 **Do not support collaboration**
How do we work together as teams with tools that are disjointed and do not scale? Let alone, not design to support teams

# How to Achieve Our Goals



With historic knowledge and human power can be make decisions?

Knowledge

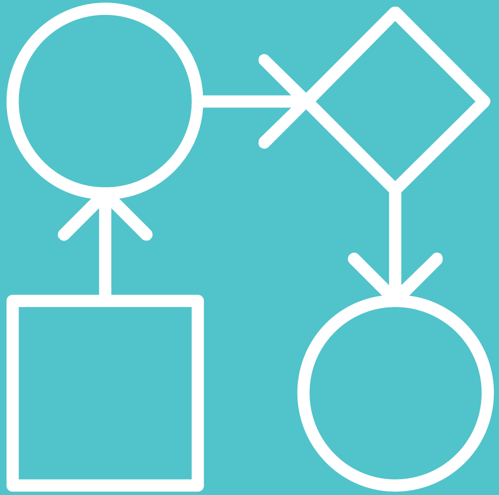
How do we then make sense of these features?

Information

How do we extract useful features?

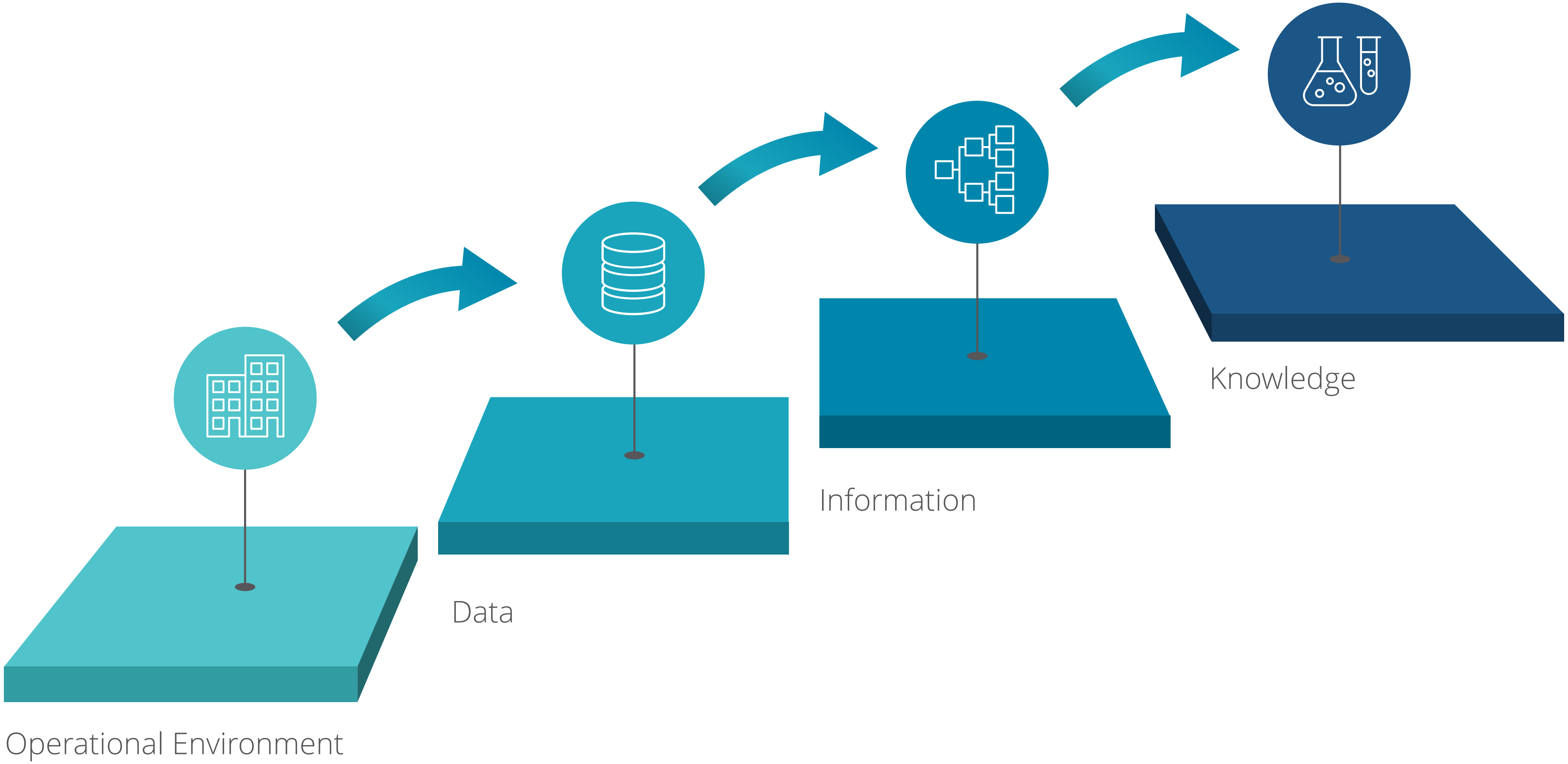
Raw Data

How do we manage the volume?



# The Analytic Lifecycle

# Analytic Lifecycle



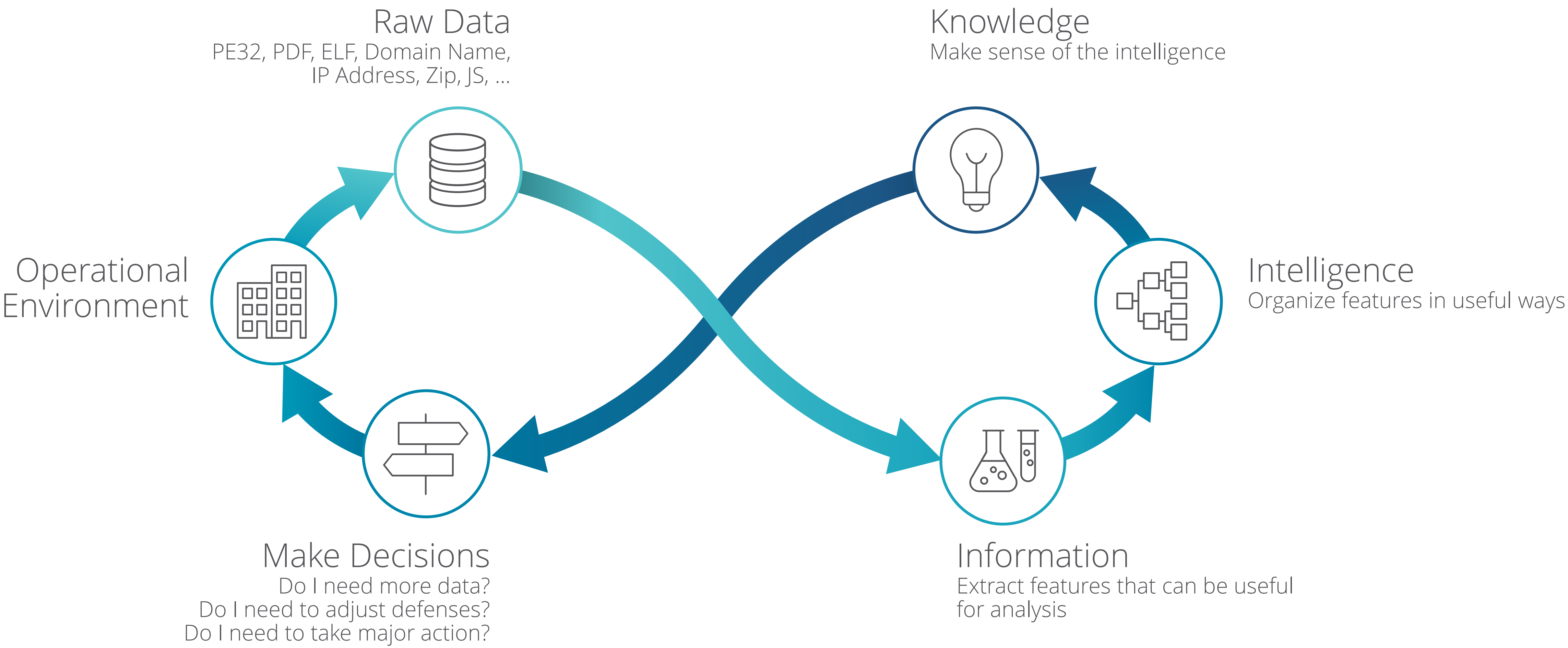
Operational Environment

Data

Information

Knowledge

# Analytic Lifecycle



Raw Data
PE32, PDF, ELF, Domain Name,
IP Address, Zip, JS, ...

Knowledge
Make sense of the intelligence

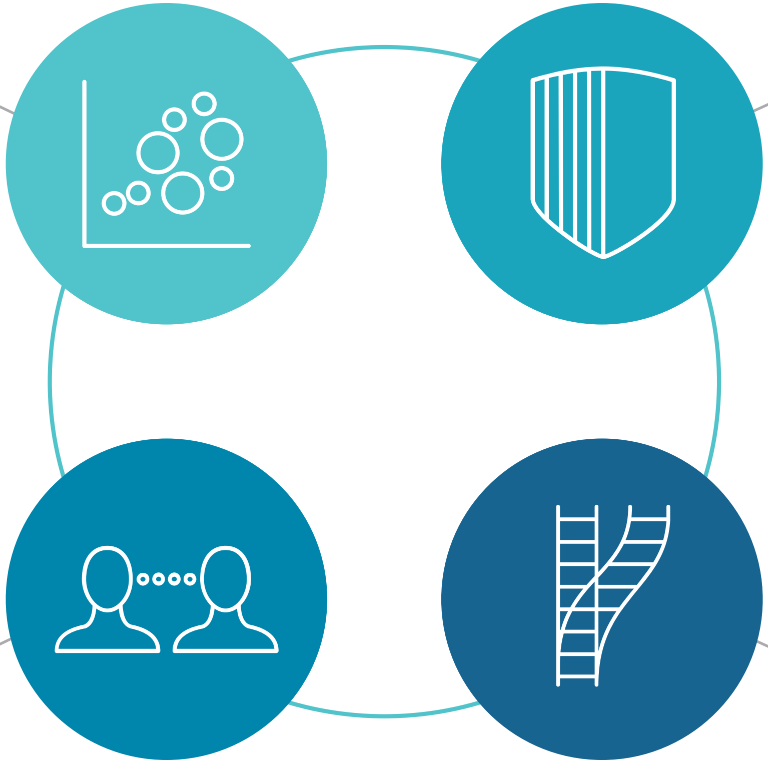
Operational
Environment

Intelligence
Organize features in useful ways

Make Decisions
Do I need more data?
Do I need to adjust defenses?
Do I need to take major action?

Information
Extract features that can be useful
for analysis

# Support for the Analytic Lifecycle



## Scalable

Cope with the volume of data

## Resilient

Handle errors gracefully, stable environment

## Collaborative

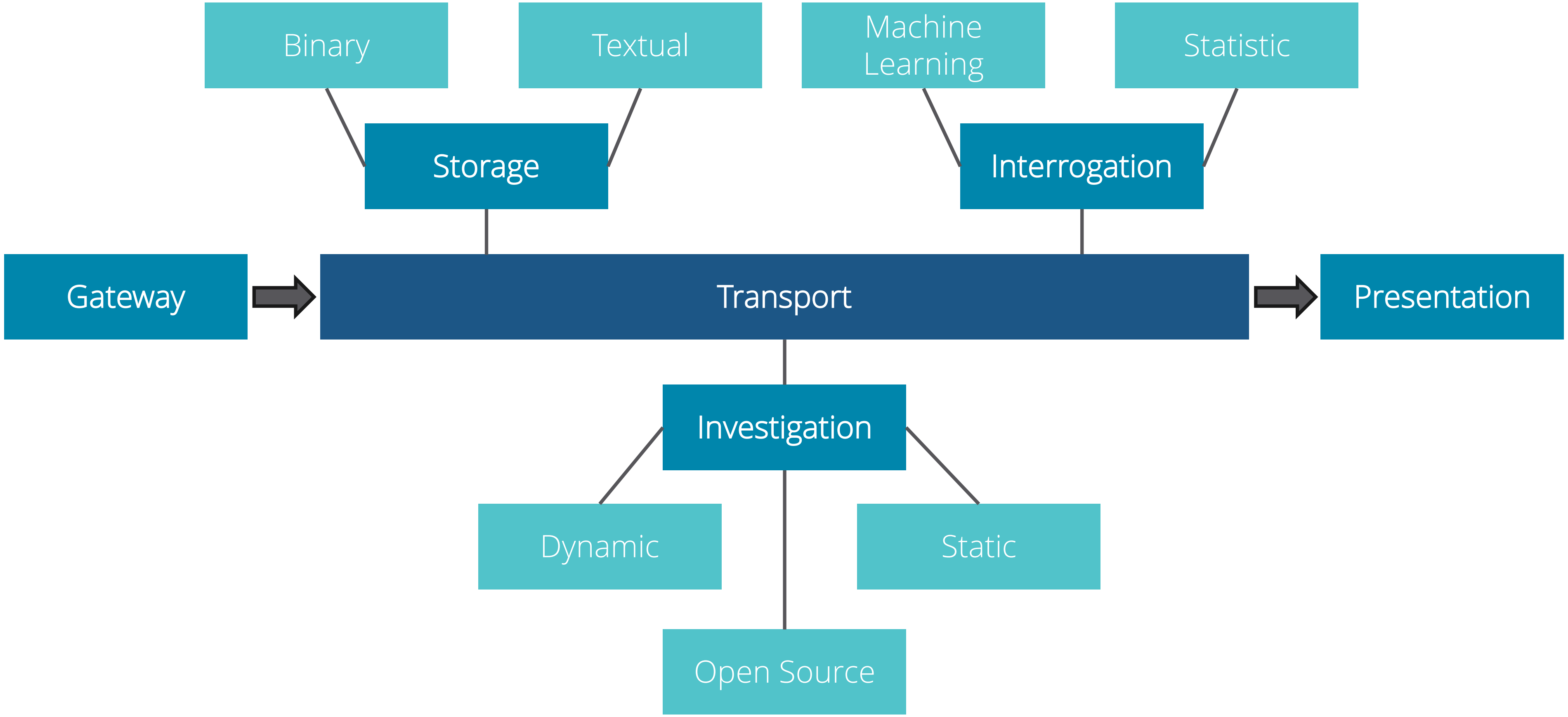
Enable teams and peers to work together

## Flexible

Incorporate future trends and methods

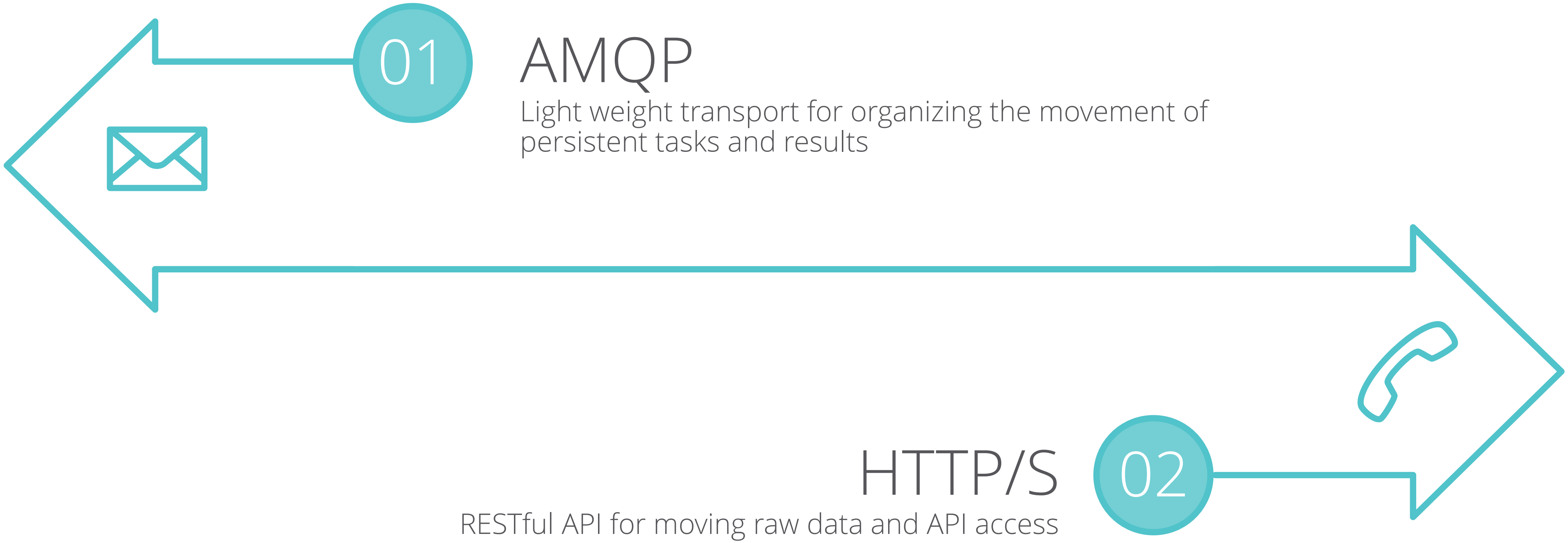
# SKALD & Holmes Processing

# SKALD



- Transport – Moves data between planners
- Planner – Orchestrates execution of taskings
- Service – Executes work

# Transport



01

## AMQP

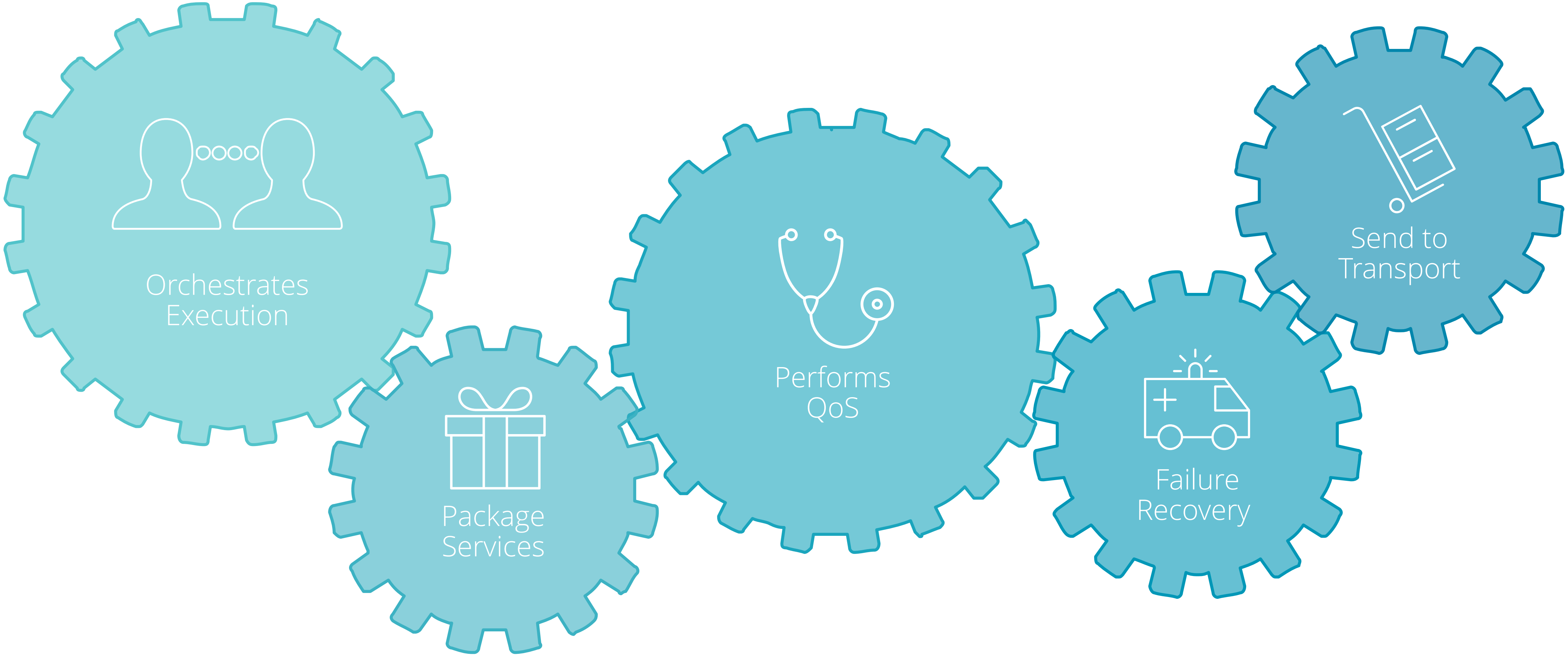
Light weight transport for organizing the movement of persistent tasks and results

02

## HTTP/S

RESTful API for moving raw data and API access

# Planner



Orchestrates Execution

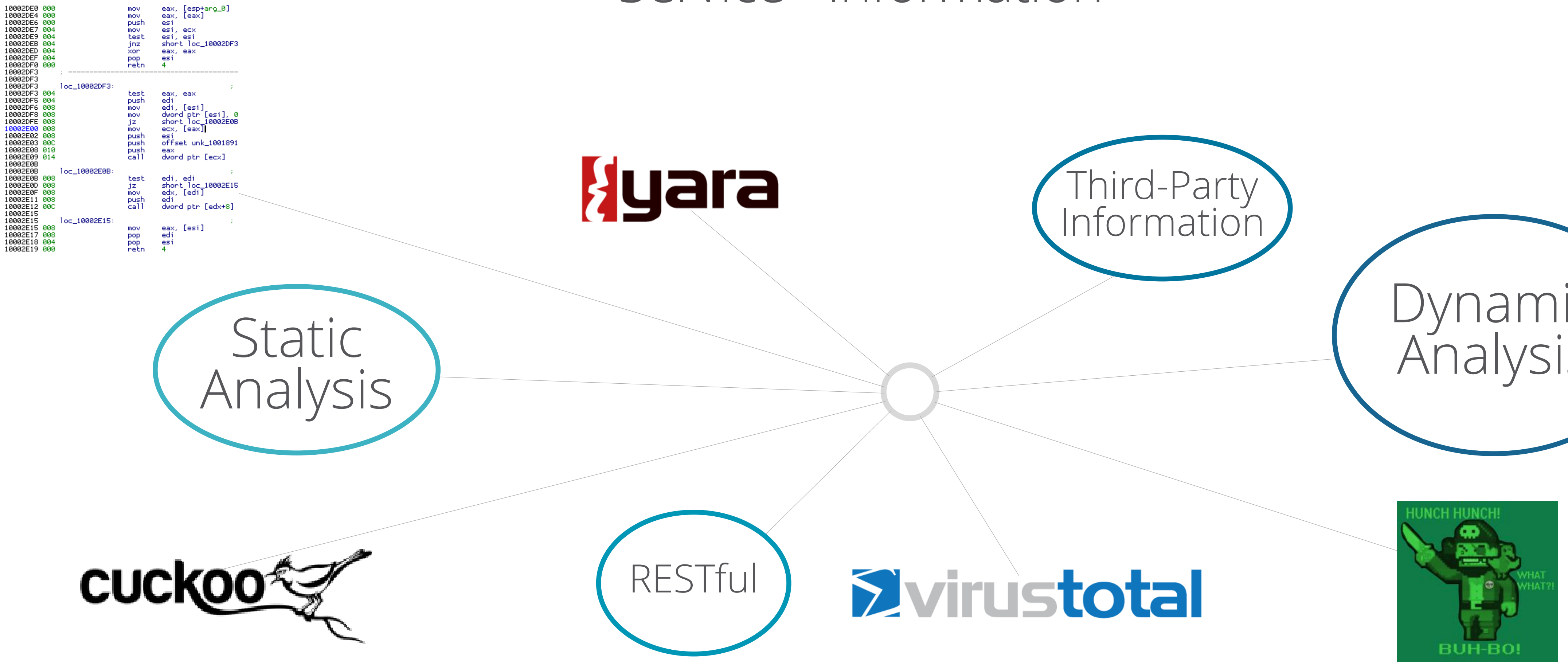
Package Services

Performs QoS

Failure Recovery

Send to Transport

# Service - Information



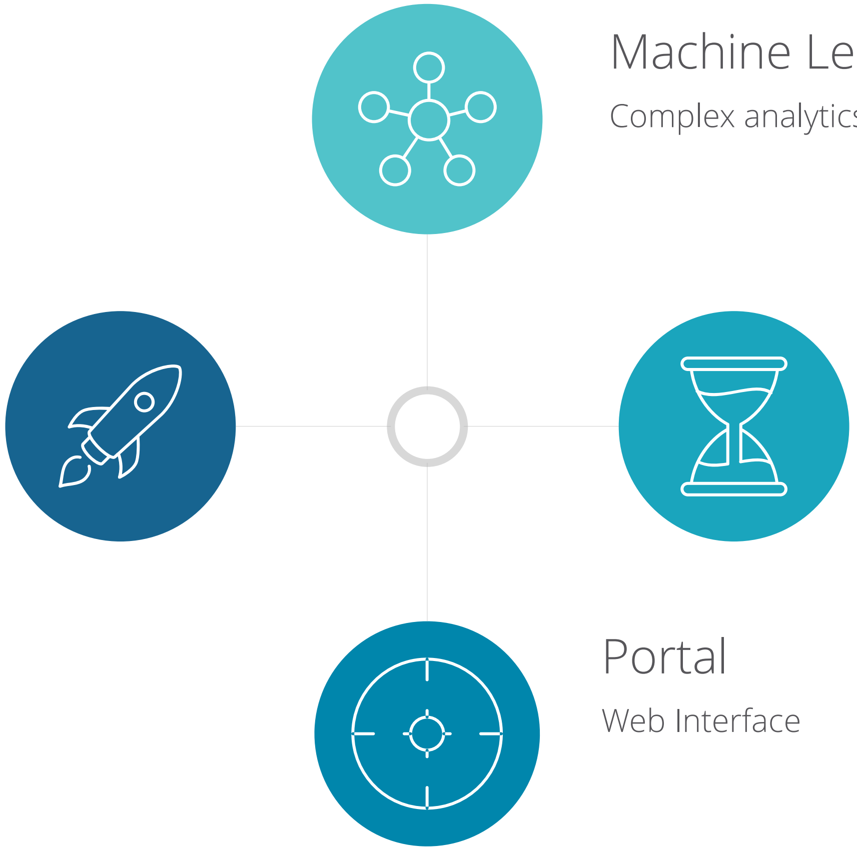
```
10002DE0 000                mov     eax, [esp+arg_0]
10002DE4 000                mov     eax, [eax]
10002DE6 000                push    esi
10002DE7 004                mov     esi, ecx
10002DE9 004                test    esi, esi
10002DEB 004                jnz     short loc_10002DF3
10002DED 004                xor     eax, eax
10002DEF 004                pop     esi
10002DF0 000                retn    4
10002DF3         ; ---------------------------------------------
10002DF3
10002DF3         loc_10002DF3:                              ;
10002DF3 004                test    eax, eax
10002DF5 004                push    edi
10002DF6 008                mov     edi, [esi]
10002DF8 008                mov     dword ptr [esi], 0
10002DFE 008                jz      short loc_10002E0B
10002E00 008                mov     ecx, [eax]
10002E02 008                push    esi
10002E03 00C                push    offset unk_1001891
10002E08 010                push    eax
10002E09 014                call    dword ptr [ecx]
10002E0B
10002E0B         loc_10002E0B:                              ;
10002E0B 008                test    edi, edi
10002E0D 008                jz      short loc_10002E15
10002E0F 008                mov     edx, [edi]
10002E11 008                push    edi
10002E12 00C                call    dword ptr [edx+8]
10002E15
10002E15         loc_10002E15:                              ;
10002E15 008                mov     eax, [esi]
10002E17 008                pop     edi
10002E18 004                pop     esi
10002E19 000                retn    4
```

Focused Work – Optimized to perform one job

Loosely Coupled – If a failure occures it does not propigate

RESTful – Easy to understand interaction methods

# Service - Knowledge



Machine Learning

Complex analytics

Graphical Representation

Maltigo, Palantir, etc

Statistics

Basic statistics

Portal

Web Interface

# What is our System?

# Holmes Processing

**Gateway**
Receiving tasking and objects

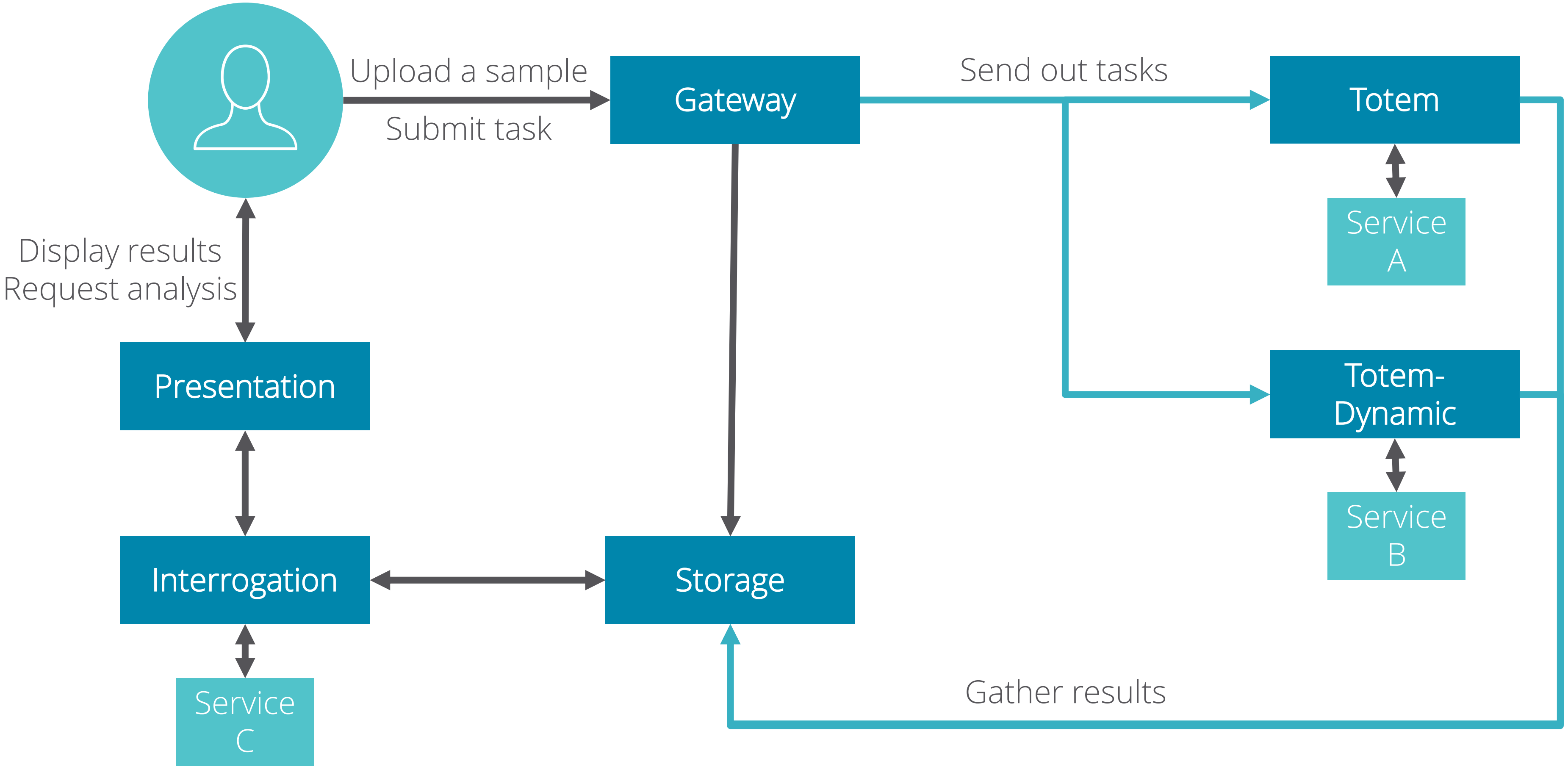
**Totem**
High performance scheduler

**Totem-Dynamic**
Long running scheduler

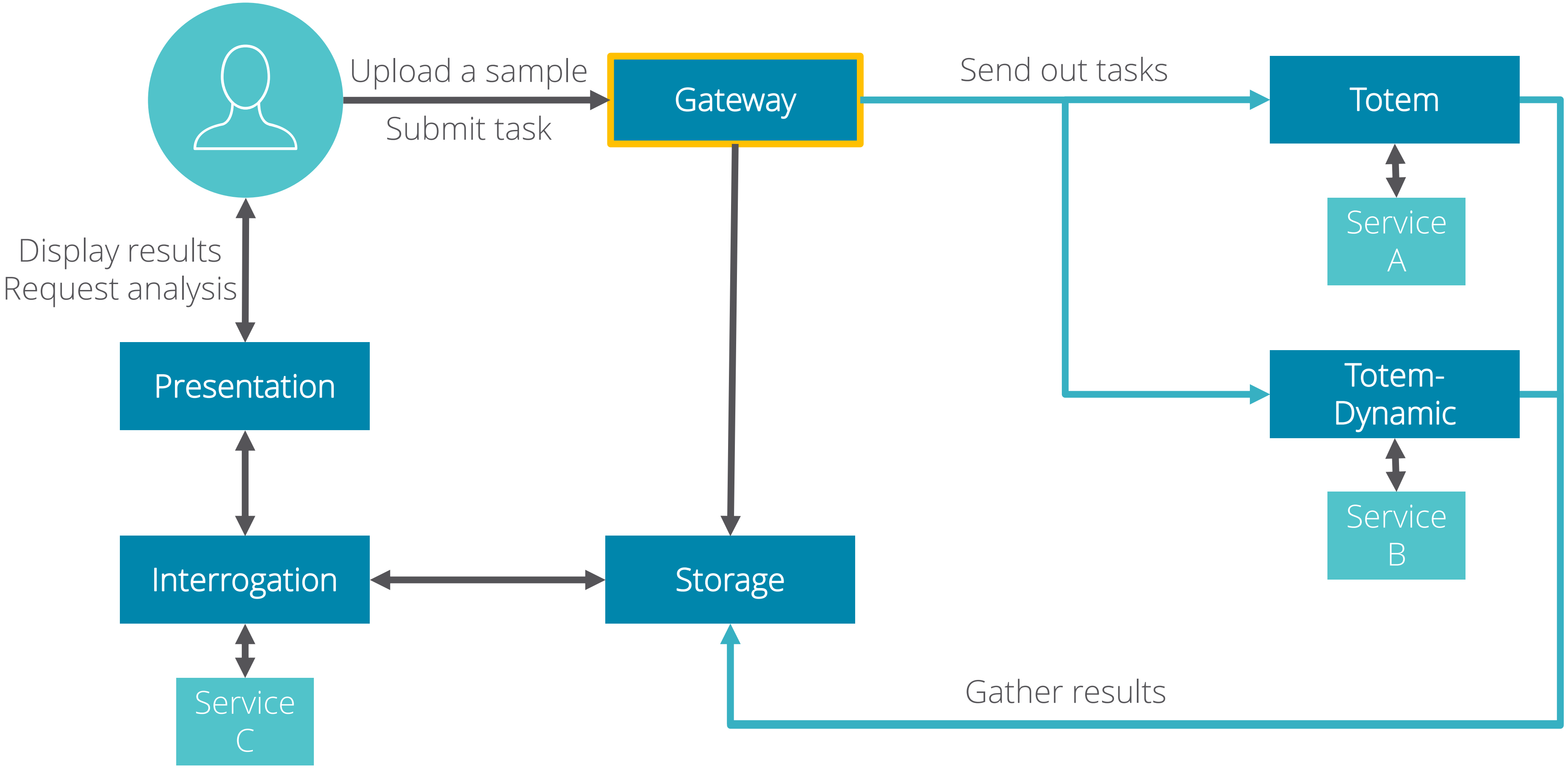
**Storage**
Lightweight data access and management

**Interrog-ation**
Data analysis and presentation

# How it All Fits Together



# What is the Gateway?



# Holmes Gateway

A sophisticated router orchestrating the **submission of new samples** as well as **sending tasks** to Totem and Totem-Dynamic.

01

Go

One statically compiled binary for all platforms

02

HTTP API

Easy to access and integrate into your tools

03

UAC & ACL

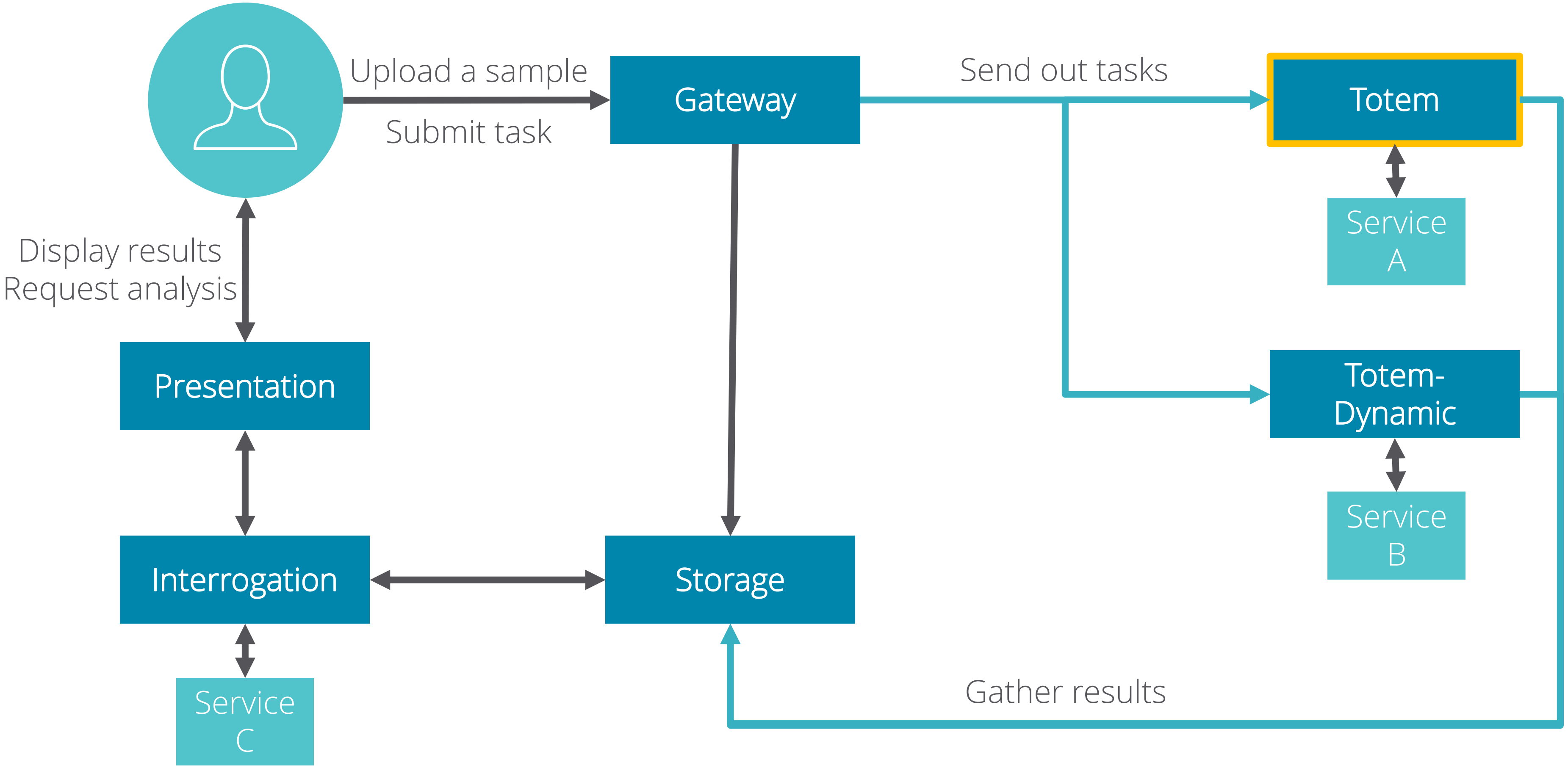
Enforce strict access policies onto all users

04

Sharing

Allow analysis without access to raw data

# What is Totem?



# Holmes Totem

High performance scheduler performing feature extraction against submitted objects. Optimized for fast Services. i.e. static analysis

01

JVM

Easy to build and deploy on commodity HW

02

Akka

Highly concurrent and memory efficient

03

AMQP

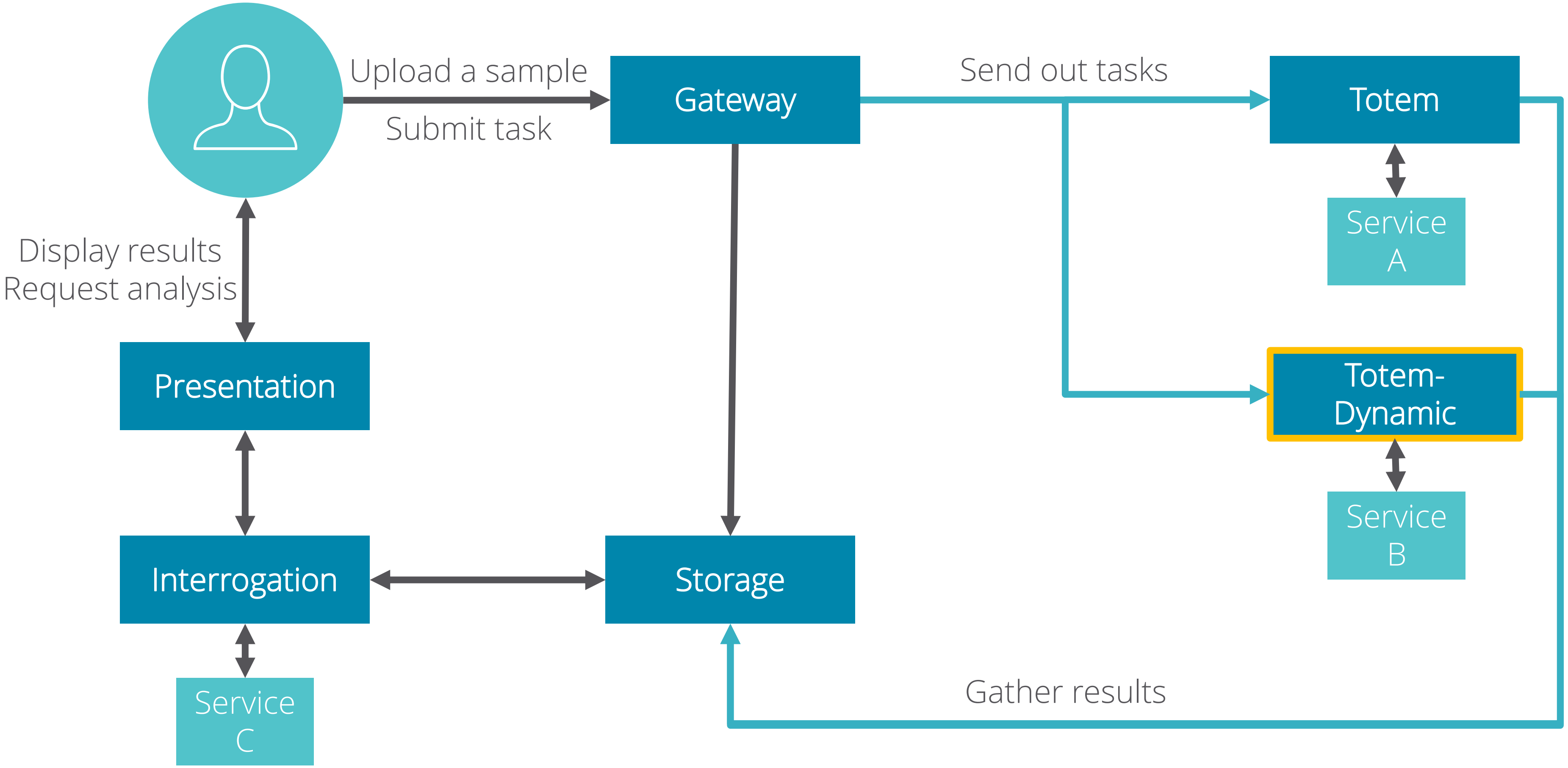
Small footprint sending and receiving

04

Docker

Containerized, easy to setup services

# What is Totem-Dynamic?



# Holmes Totem-Dynamic

A planner specifically designed for long running analysis and unpredictable third party Services. i.e. Dynamic analysis

01

Go
One statically compiled binary for all platforms

02

FCS
Feed, Check, Submit - a resilient concept

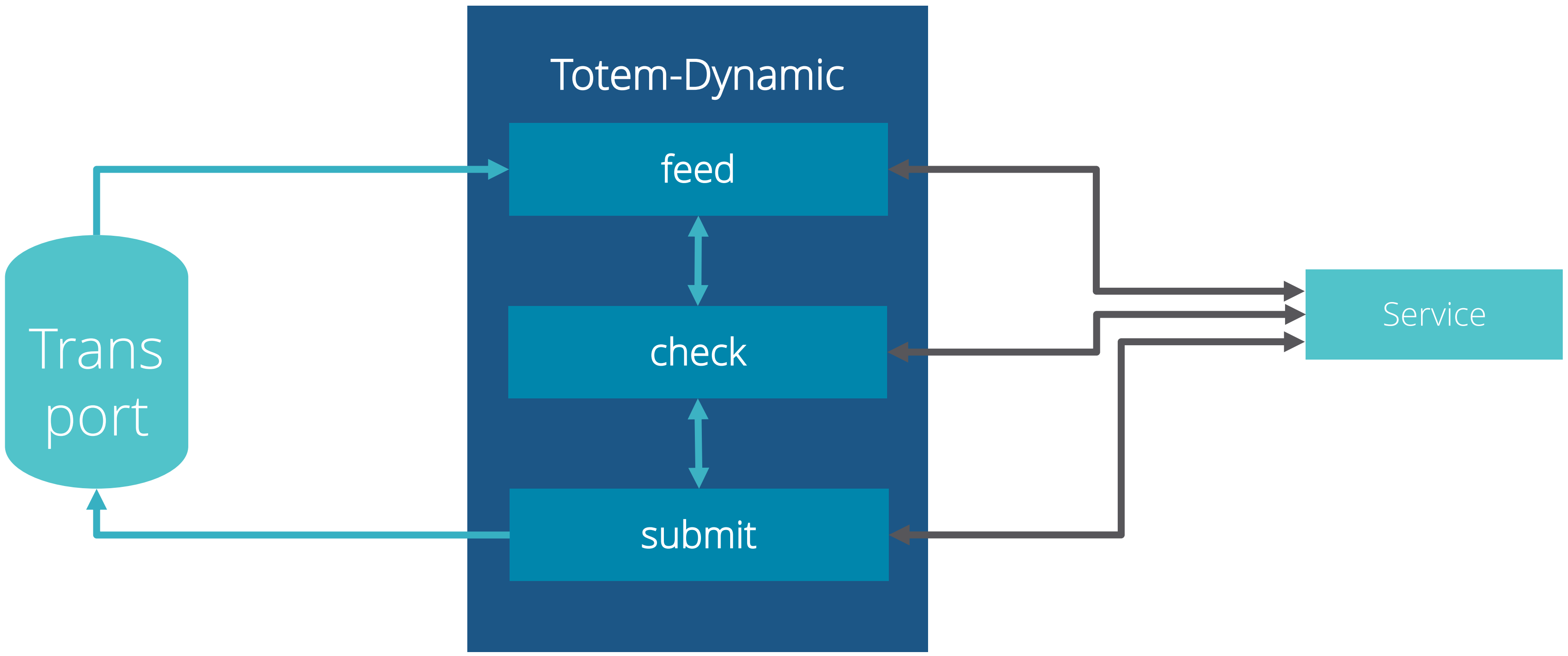
03

AMQP
Small footprint sending and receiving

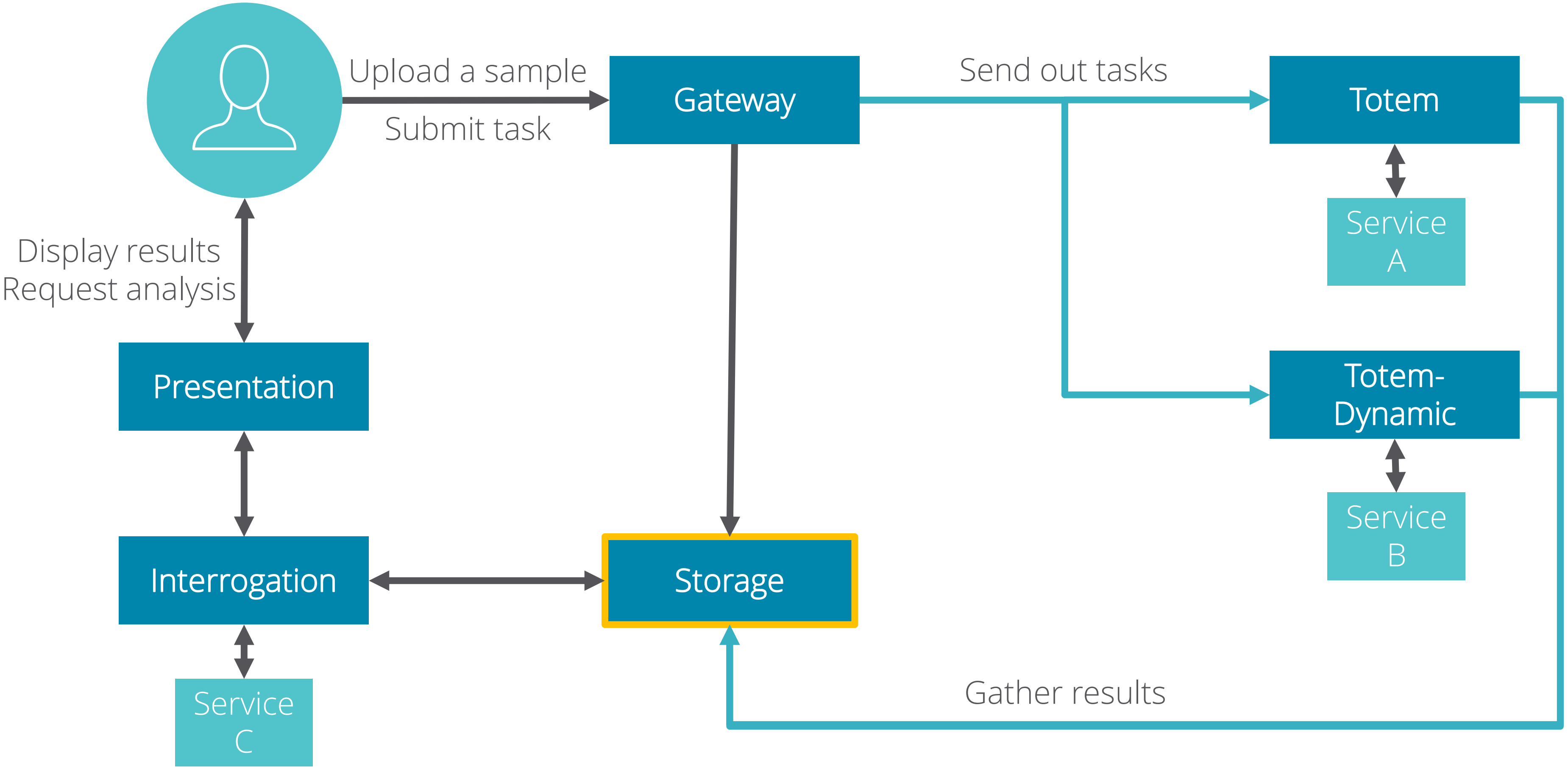
04

Docker
Containerized, easy to setup services

# Totem-Dynamic Inner Workings



# What is Storage?



# Holmes Storage

A planner designed to manage data and sample storage as well as offering an API for other planners and services to easy and secure interact with the data.

01

Go

One statically compiled binary for all platforms

02

HTTP API

Easy to use and load balance, stateless

03

AMQP

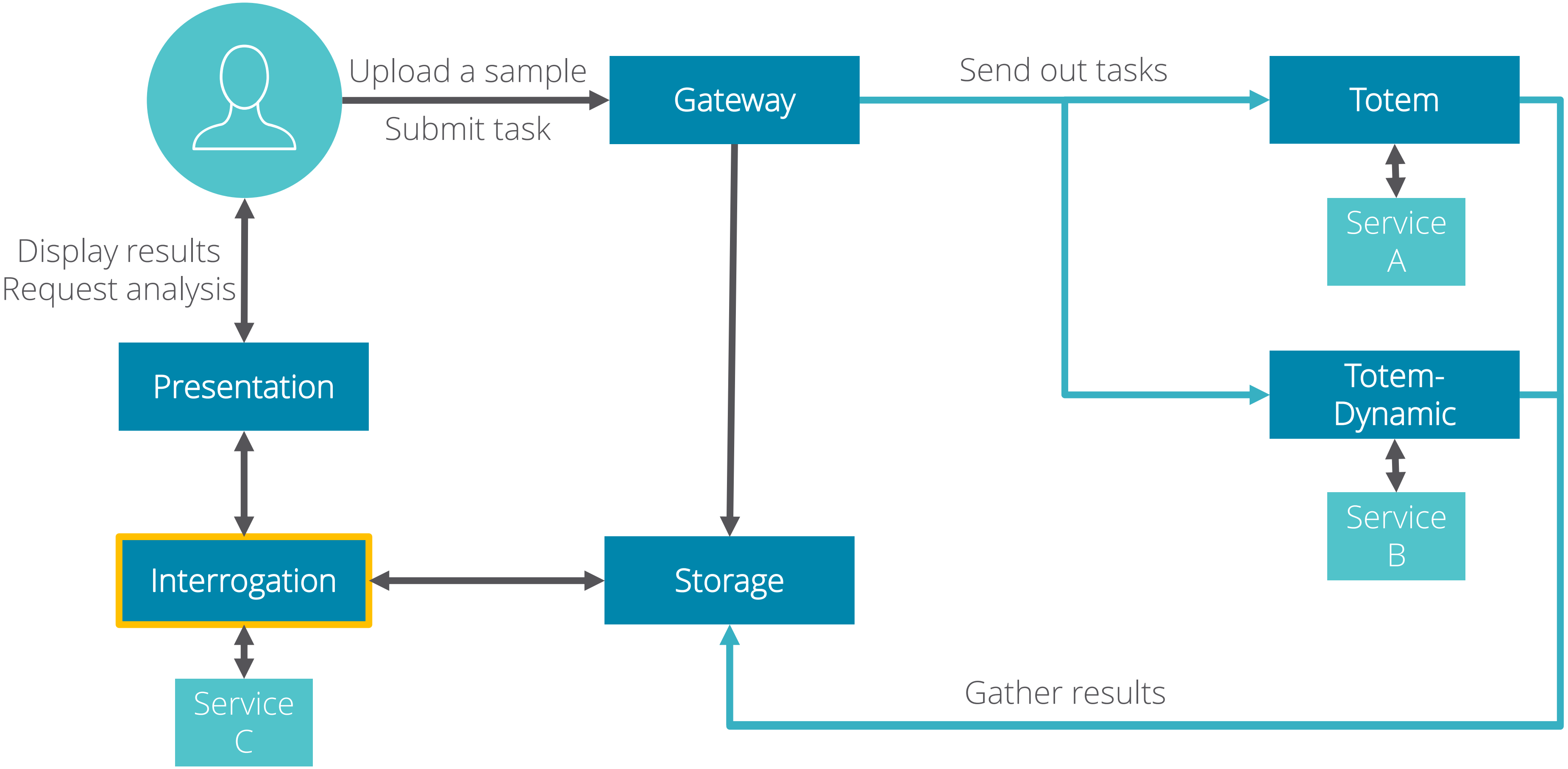
Small footprint receiving of analysis results

04

Versatile

MongoDB, Cassandra, S3, ...

# What is Interrogation?



# Holmes Interrogation

The Interrogation planner is defined by the SKALD architecture and serves as the focal point for performing analysis and render the data.

01

Go

One statically compiled binary for all platforms

02

Interface

Web Interface for easy of use and visualization

03

ML

Machine Learning Support

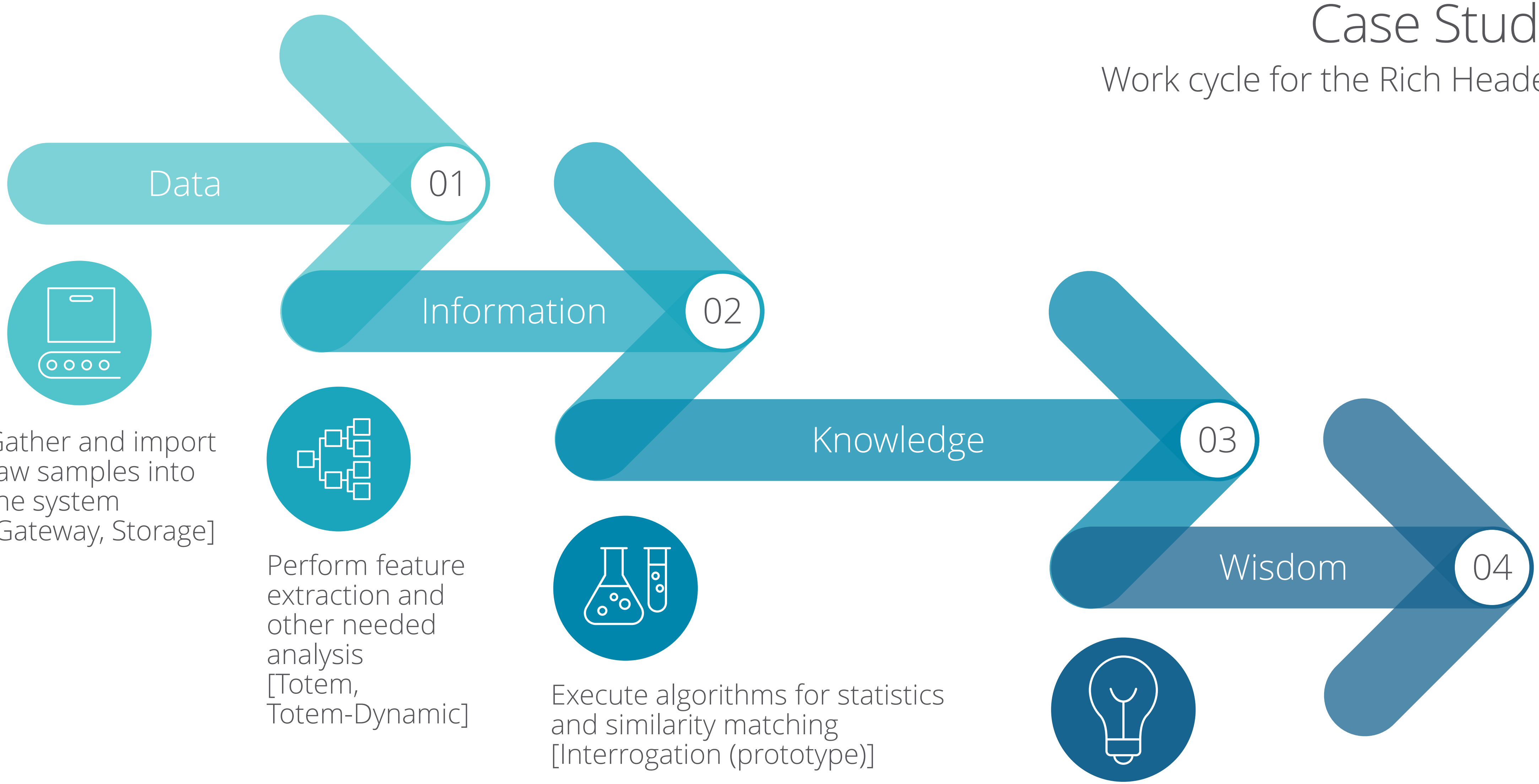
04

ALPHA

Very much under development!

# Case Study

Work cycle for the Rich Header



Data 01

Gather and import raw samples into the system [Gateway, Storage]

Information 02

Perform feature extraction and other needed analysis [Totem, Totem-Dynamic]

Knowledge 03

Execute algorithms for statistics and similarity matching [Interrogation (prototype)]

Wisdom 04

Interpret our results, refine our methods, write paper

# Conclusion

# Key Takeaways

## APACHE 2 LICENSE

We developed this system in partnership with our industry partners to support our research and their operations. We have had great success and we hope it helps you as well.

01 **Supports the analytic life cycle**

02 **Scalable, resilient, flexible**

03 **Supports collaboration**

04 **Use the parts you want**

# Hold Tight and Pretend There is a Plan

01

### Release Interrogation Planner

Interrogation should simplify the execution and scheduling of machine learning and analytic code. We plan to release the code within the next few months

02

### Implement advanced sharing model

Version 2 of the sharing model will simplify the exchange of information and sharing of infrastructure

03

### Centralize configuration management

We plan to allow the ability to automatically configure Planners and Services through Storage

04

### Monitoring of Planners and Services

We want to extend the monitoring capabilities of the system and output the information through an API and the website

# Love Your Help

## 01

### Write Services

We love receiving new extraction methods for Totem and Totem-dynamic. As we build out Interrogation, new ML methods will become critical

## 02

### Add Elastic

We supply MV and 2nd indexing for Cassandra. Extending Storage to support Elastic across the raw information would be much appreciated

## 03

### Improvements

We do this work on the side. Anything from bug fixes, to general improvements, to documentation, to pretty artwork would be wonderful

## 04

### Samples

We need samples and love anything that has labels. It is a huge benefit to our research and on many different fronts

Thank You

- Capital One
- Global Cyber Alliance
- Google Summer of Code
- RiskIQ
- Technical University of Munich
- The Honeynet Project
- VirusShare
- VirusTotal
- And many others

George Webster &
Christian von Pentz
{webstergd,pentz}@sec.in.tum.de
Technical University of Munich
Chair for IT Security
holmesprocessing.github.io