I don't feel so well – Integrating health checks in your .NET Core solutions

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DOTNEXT
.NET КОНФЕРЕНЦИЯ

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Challenges for large-scale distributed systems

Keeping entire system running

Determine state of entire system and intervene

How to know health status of individual services?

Collecting/correlating performance and health data

Events, metrics, telemetry, logs, traces

Usually centralized in a distributed landscape, e.g. micro-services

Raygun.io NewRelic AlertSite AppMetrics Azure Monitor DataDog Sentry.io Runscope

Traditional medicine and health

Doctor, am I sick? 12:34

Let's look at your vitals we measured:
- Pulse **180** per minute
- Blood pressure **150/110**

12:34

Does not look good.
It seems you are unhealthy. 12:35

Thanks, doctor! 😃 12:36

Centralized

Single point that knows how to assess health

Challenging

Combining measurements to health information

Based on generic types of measured values

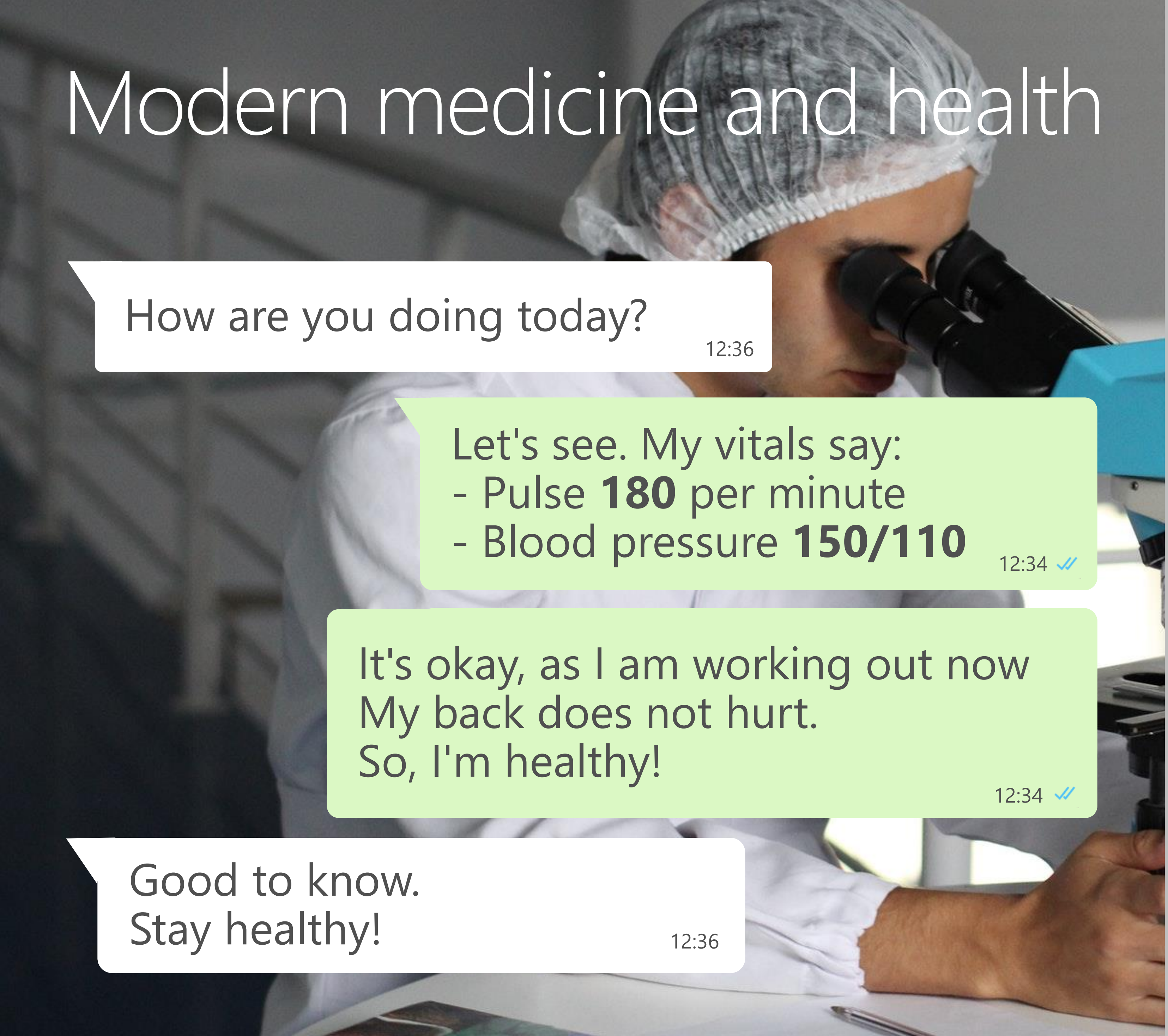
Absence of measurements

Differences in behavior from person to person

Unknown internals

Multiple places to access health

Modern medicine and health



How are you doing today?
12:36

Let's see. My vitals say:
- Pulse **180** per minute
- Blood pressure **150/110**
12:34

It's okay, as I am working out now
My back does not hurt.
So, I'm healthy!
12:34

Good to know.
Stay healthy!
12:36

Self-assessment

Determing your own health status

Know what defines healthy and unhealthy

Context matters

Measurements might need to be interpreted differently

Depending on:

- Situation
- Circumstances
- Unmeasurable values

You know best

Difference between metrics and health info

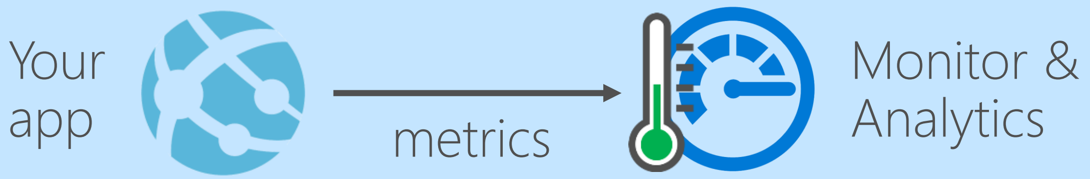
Metrics

Many individual measured values and counts of events

Watch performance and trends

Useful for diagnostics and troubleshooting

Logic external to origin



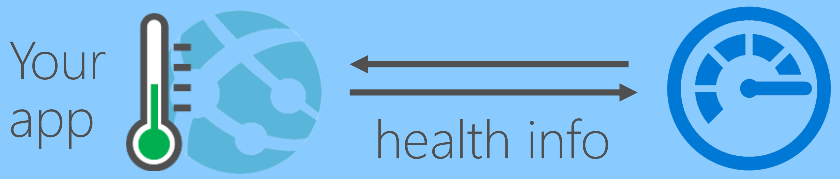
Health

Intrinsic knowledge of implementation required

DevOps mindset:

Logic to determine health is part of origin

Deployed together, good for autonomy



Levels of health

Simple

Availability

Any response
Status code indication
Formal endpoints

Latency

Time to respond

Internals

Memory
Disk space

Advanced

External dependencies

- URL endpoints (e.g. Web API or CDN)
- Databases
- Service bus or queue
- Storage

Readiness & liveliness

Distinguish startup and normal operation
Good for external lifetime management

Preventive

Predicting

- Indication of impending failure
- Interesting with AI and ML

Examples

- Expiring certificates
- Trends in memory pressure
- Failing resiliency countermeasures

Health status

Healthy

200 OK

"Everything is fine"

Degraded

200 OK

"Could be doing better or about to become unhealthy"

Unhealthy

503 Service Unavailable

"Not able to perform"

Integrating health checks

New in .NET Core 2.2

Available to all .NET Core applications
Plugs into ASP.NET Core

Microsoft.Extensions.Diagnostics.HealthChecks
.Abstractions
.EntityFramework

Microsoft.AspNetCore.Diagnostics.HealthChecks

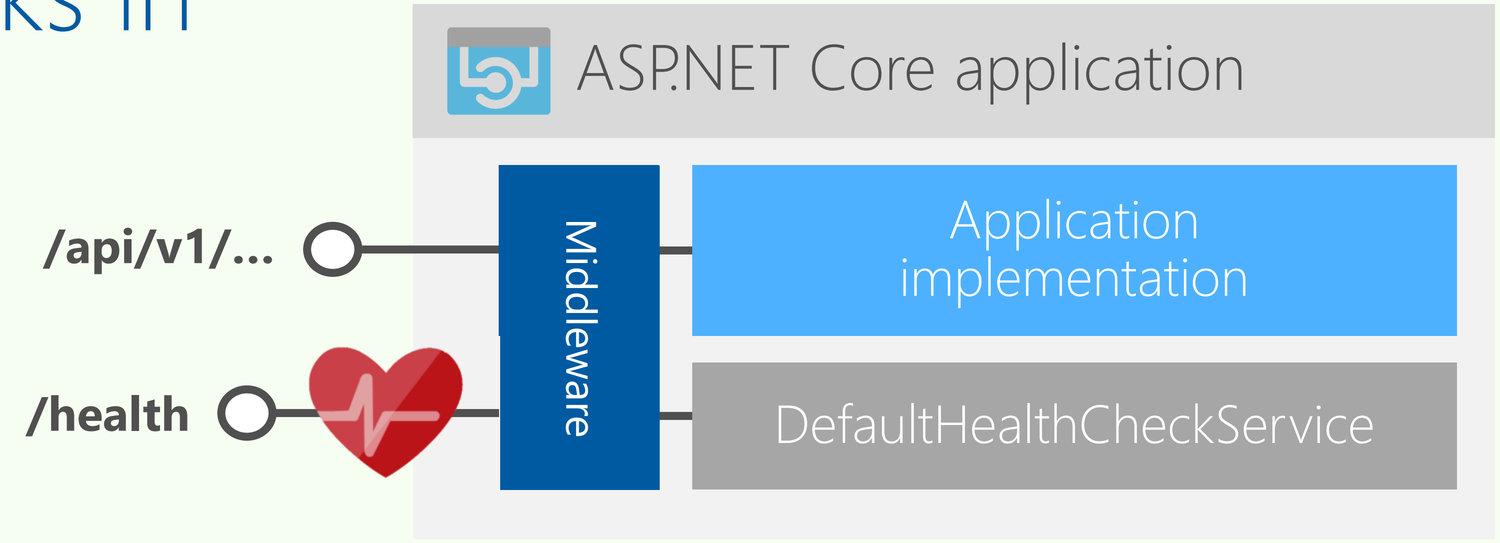
Bootstrap health checks in ASP.NET Core app

Dependency injection

```
services.AddHealthChecks();
```

ASP.NET Core middleware routing

```
app.UseHealthChecks("/health");
```



Using health checks

When a service is unhealthy, how can you trust its health status?

What?

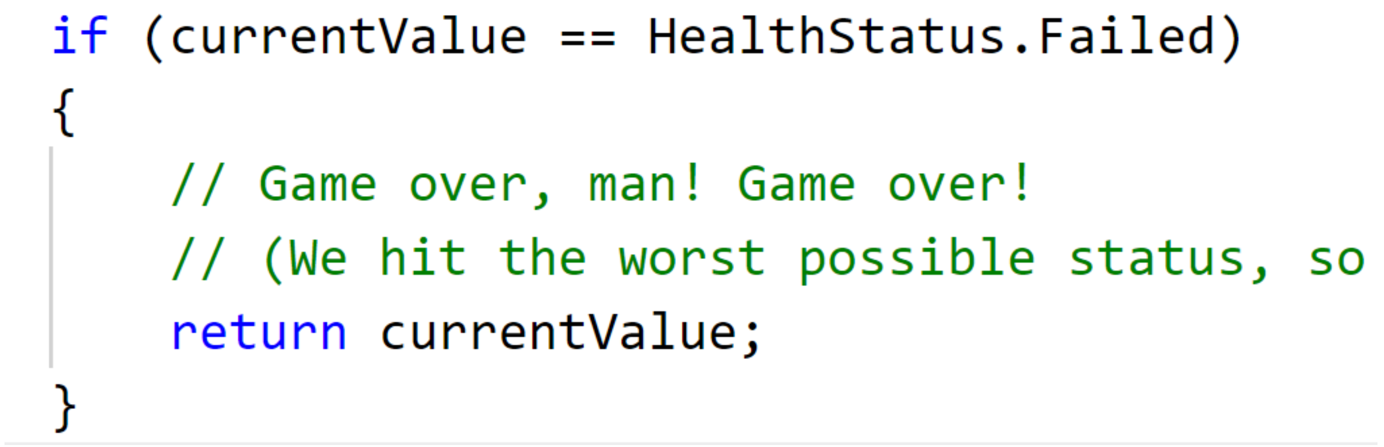
```
public interface IHealthCheck
{
  Task<HealthCheckResult> CheckHealthAsync(
    HealthCheckContext context,
    CancellationToken cancellationToken = default);
}
```

When?

On demand from endpoints
Periodically by publishers

How?

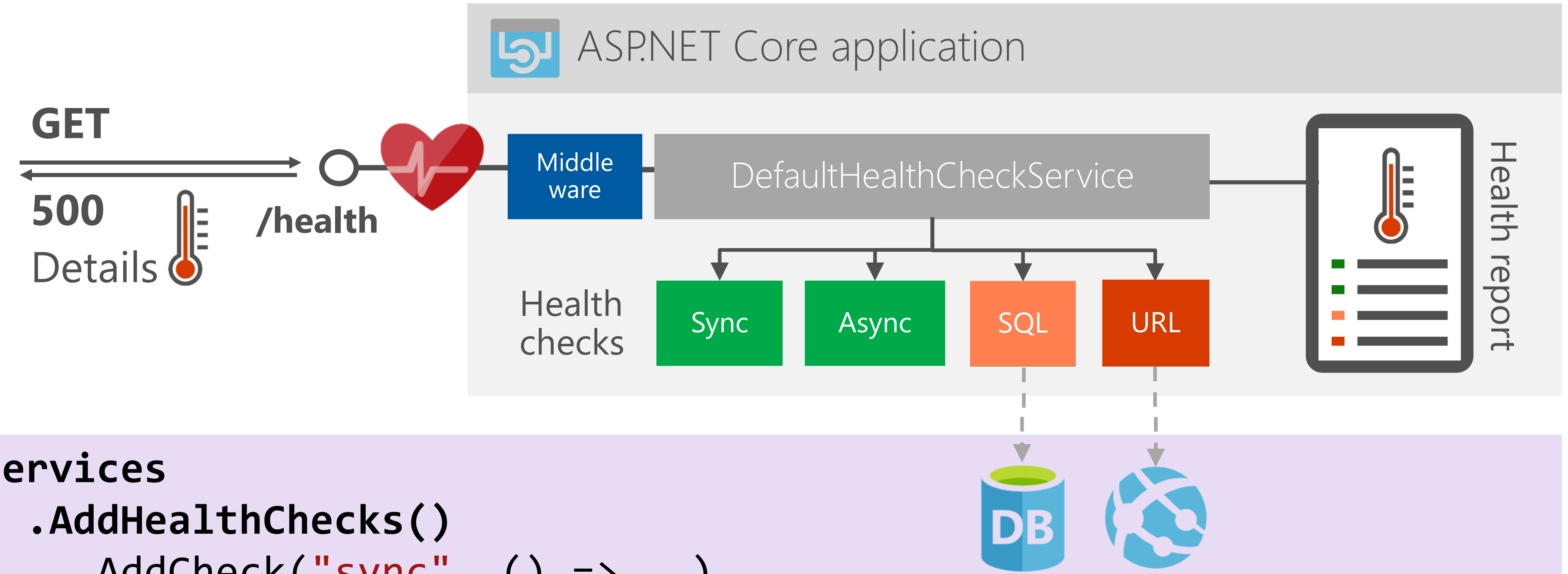
Iterating over health check registrations



```
if (currentValue == HealthStatus.Failed)
{
    // Game over, man! Game over!
    // (We hit the worst possible status, so
    return currentValue;
}
```

From: https://github.com/aspnet/Diagnostics/blob/master/src/Microsoft.Extensions.Diagnostics.HealthChecks.Abstractions/HealthReport.cs

Integrating health checks

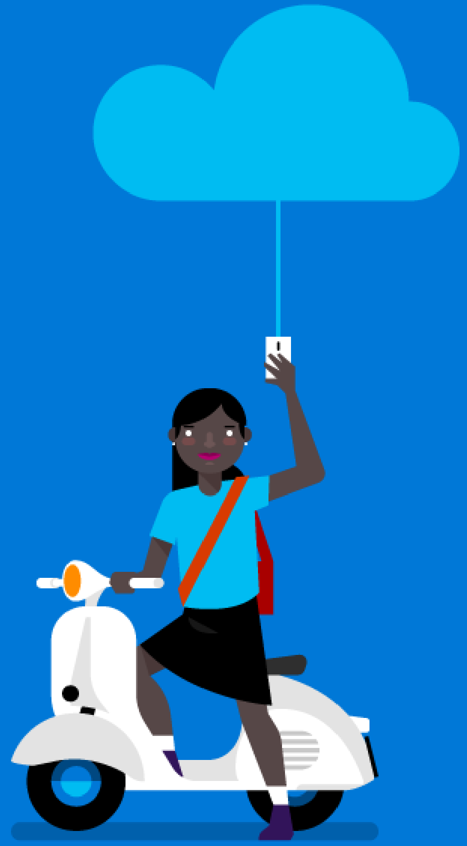


```
services
   .AddHealthChecks()
      .AddCheck("sync", () => … )
      .AddAsyncCheck("async", async () => … )
      .AddCheck<SqlConnectionHealthCheck>("SQL")
      .AddCheck<UrlHealthCheck>("URL");
```

Demo

ASP.NET Core 2.2 Health object model

Health checks
Endpoints



Custom health checks

Only 1 out-of-box check

Entity Framework `DbContext`

Microsoft.Extensions.Diagnostics.
HealthChecks.EntityFrameworkCore

```
services.AddHealthChecks()
    .AddDbContextCheck<GamingDbContext>("EF")
```

Build your own

1. Delegate for sync or async factory
2. Implementation of `IHealthCheck`

Community packages

AspNetCore.Diagnostics.HealthChecks.*

Xabaril/BeatPulse

System (Disk Storage, Memory)
Network (Tcp, Ftp, Sftp, Imap, Smtp, Dns resolve)
Azure Storage (Blobs, Tables and Queues)
Azure Service Bus (Event Hub, Service Bus queues and topics)
RabbitMQ
Kafka
Redis
Elasticsearch
EventStore
Identity Server
AWS DynamoDB

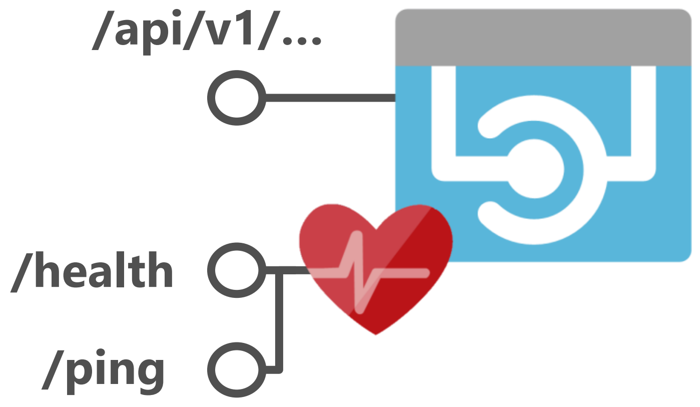
SqlServer
MongoDb
Oracle
DocumentDb
MySQL
SqLite
Postgress Sql

Yours?

Beyond the basics

Register multiple health endpoints

Order of registrations matters



Middleware options

Change HTTP status codes per health result

Allow client-side caching

Change response writing

Predicate for filtering health checks to evaluate

Register custom health check as singleton

```
services.AddSingleton<KafkaHealthCheck>());
services.AddSingleton(new SqlConnectionHealthCheck(
  new SqlConnection(Configuration.GetConnectionString("TestDB"))));
```

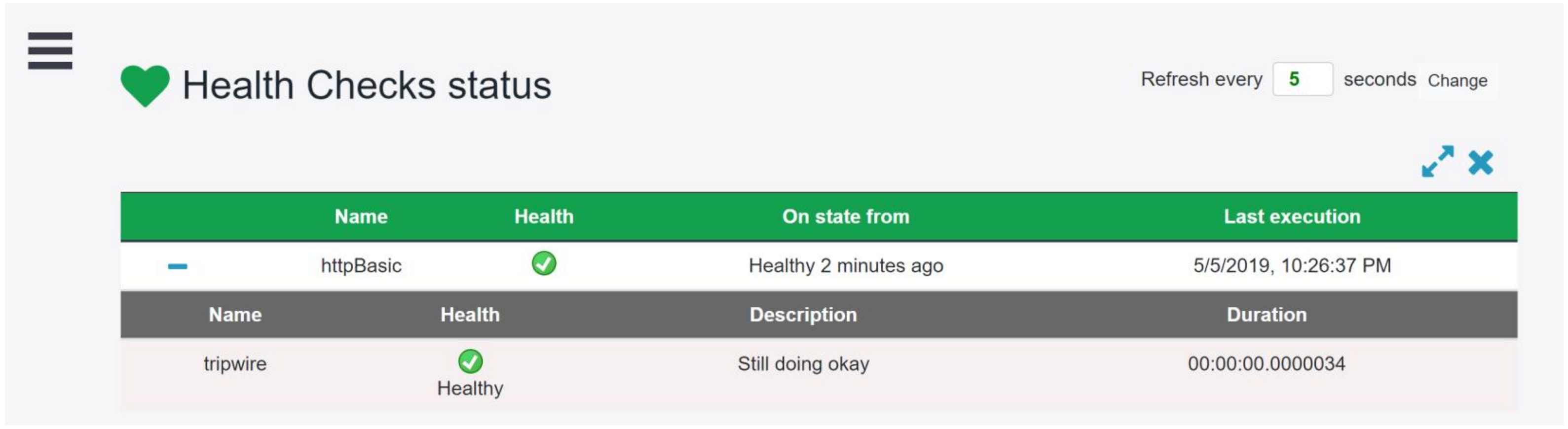
Visualizing health checks

1. Customize health endpoint output for more details

   Specify delegate from HealthCheckOptions.ResponseWriter
2. Query endpoint(s)
3. Build user interface

Xabaril BeatPulse AspNetCore.HealthChecks.UI

- Host in ASP.NET Core application
- Run from Docker container



Health Checks status

Refresh every 5 seconds Change

	Name	Health	On state from	Last execution
–	httpBasic	✓	Healthy 2 minutes ago	5/5/2019, 10:26:37 PM

Name	Health	Description	Duration
tripwire	✓ Healthy	Still doing okay	00:00:00.0000034

Demo
A bit more advanced

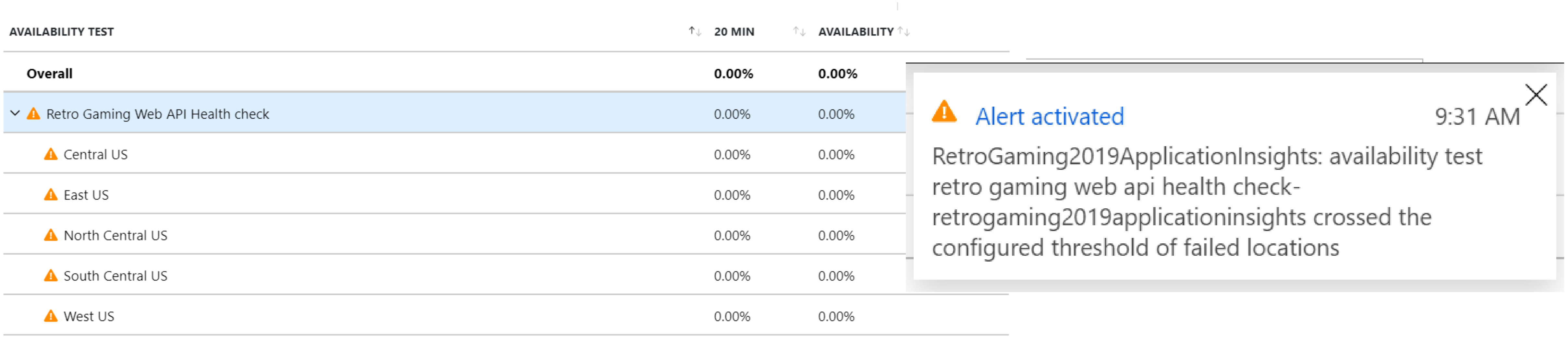
Monitoring health

Endpoints

Frequency

Locations

Alerts



AVAILABILITY TEST	20 MIN	AVAILABILITY
Overall	**0.00%**	**0.00%**
Retro Gaming Web API Health check	0.00%	0.00%
Central US	0.00%	0.00%
East US	0.00%	0.00%
North Central US	0.00%	0.00%
South Central US	0.00%	0.00%
West US	0.00%	0.00%

Alert activated 9:31 AM

RetroGaming2019ApplicationInsights: availability test retro gaming web api health check-retrogaming2019applicationinsights crossed the configured threshold of failed locations

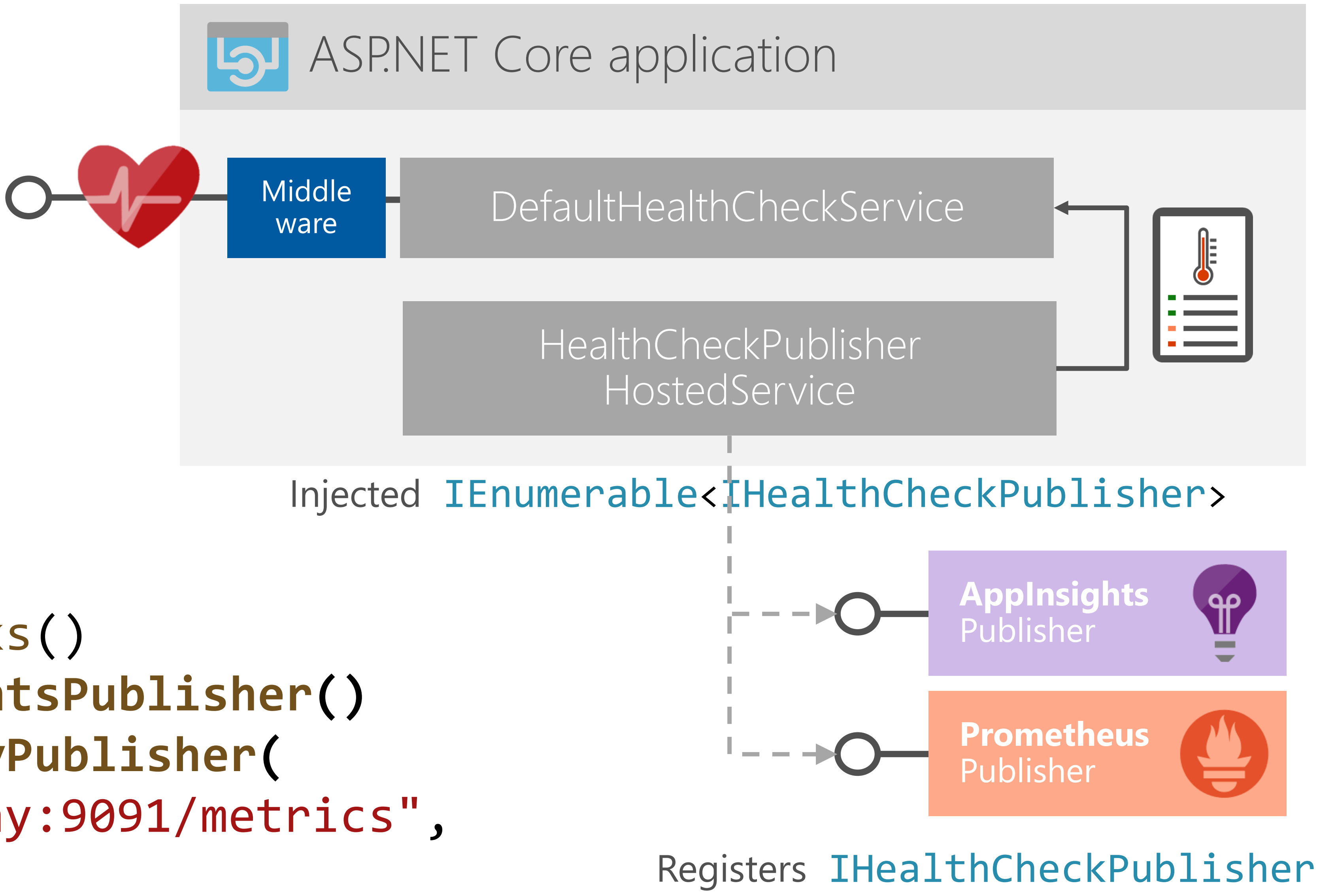
Health check publishers

Pushes out health info periodically

Options

Timeout: max time to execute check
Delay: time to wait after startup
Period: period of execution
Predicate: Filter for checks to execute

```
services.AddHealthChecks()
  .AddApplicationInsightsPublisher()
  .AddPrometheusGatewayPublisher(
     "http://pushgateway:9091/metrics",
     "pushgateway")
```

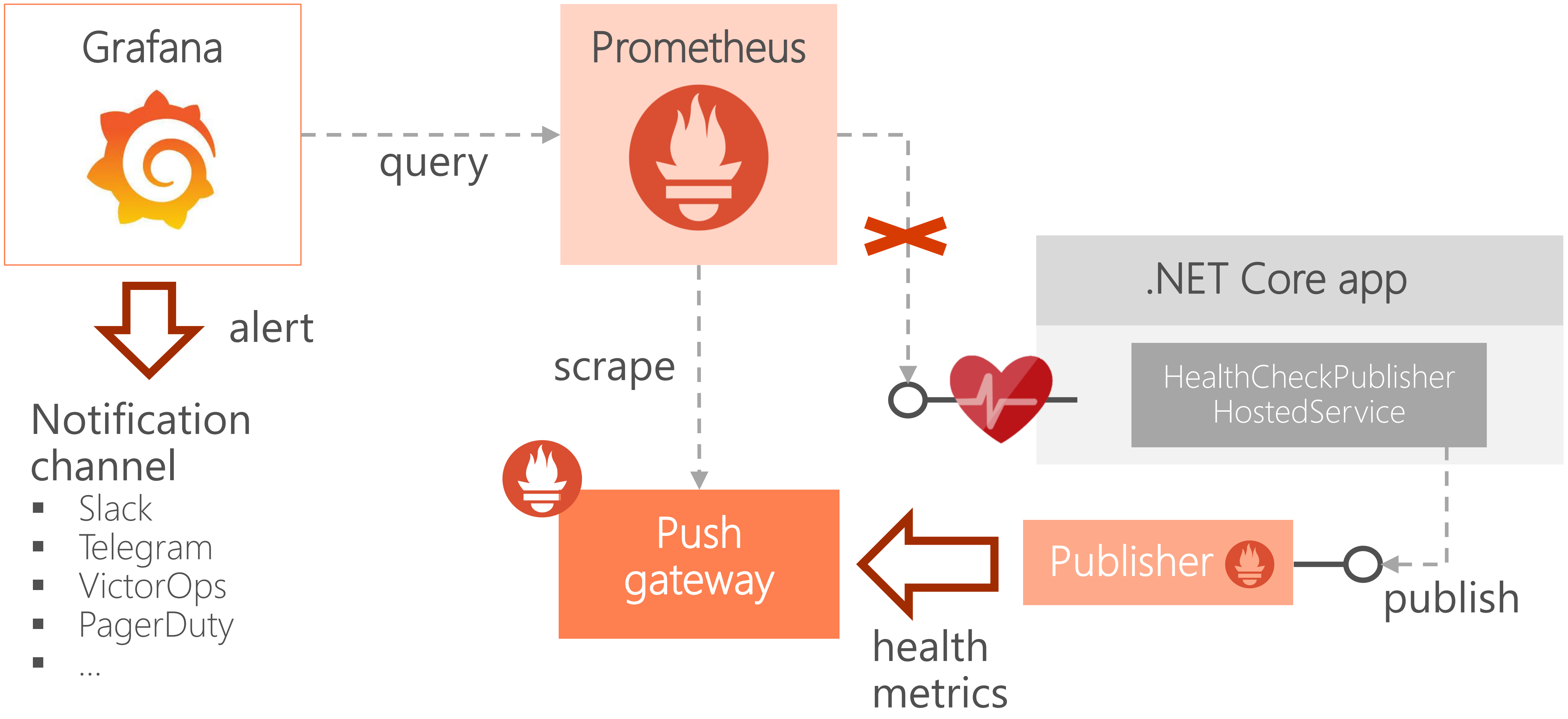

ASP.NET Core application
Middle ware
DefaultHealthCheckService
HealthCheckPublisher HostedService
Injected IEnumerable<IHealthCheckPublisher>
AppInsights Publisher
Prometheus Publisher
Registers IHealthCheckPublisher

Caveat for .NET Core 2.2:

Registering a HealthCheckPublisher pre-.NET Core 3.0

```
// The following workaround permits adding an IHealthCheckPublisher
// instance to the service container when one or more other hosted
// services have already been added to the app. This workaround
// won't be required with the release of ASP.NET Core 3.0. For more
// information, see: https://github.com/aspnet/Extensions/issues/639.
services.TryAddEnumerable(
    ServiceDescriptor.Singleton(typeof(IHostedService),
        typeof(HealthCheckPublisherOptions).Assembly
            .GetType(HealthCheckServiceAssembly)));
```

Prometheus and Grafana



Demo

Publishers

Prometheus and Grafana

Resilient and self-healing applications

Resiliency

Use cloud patterns:

- Circuit Breaker
- Timeout
- Retry

Performance

Metrics

Instrumentation

Availability

Zero-downtime upgrades

Readiness

Liveliness

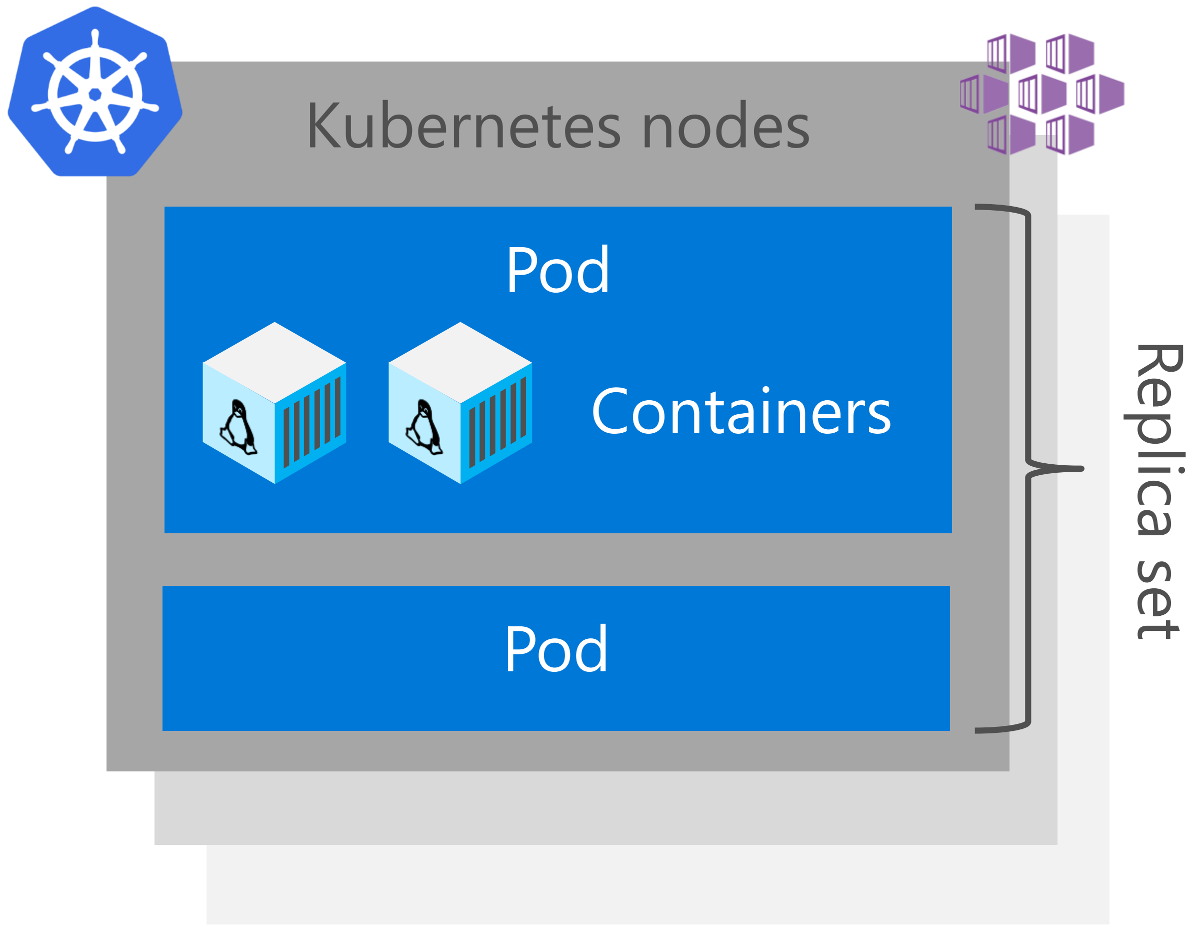
Monitoring

Health endpoint monitoring

Alerts

Readiness and liveness

Probing containers to check for availability and health



k8s-deployment.yaml

```
readinessProbe:
  httpGet:
    path: /health/ready
    port: 8080
  initialDelaySeconds: 20
  periodSeconds: 10
  timeoutSeconds: 10
  failureThreshold: 3

livenessProbe:
  httpGet:
    path: /health/lively
    port: 8080
```

Readiness

Ready to receive incoming traffic

Not ready: remove container from load balancer

Liveliness

Indicates when to restart a container

Implementing readiness and liveliness

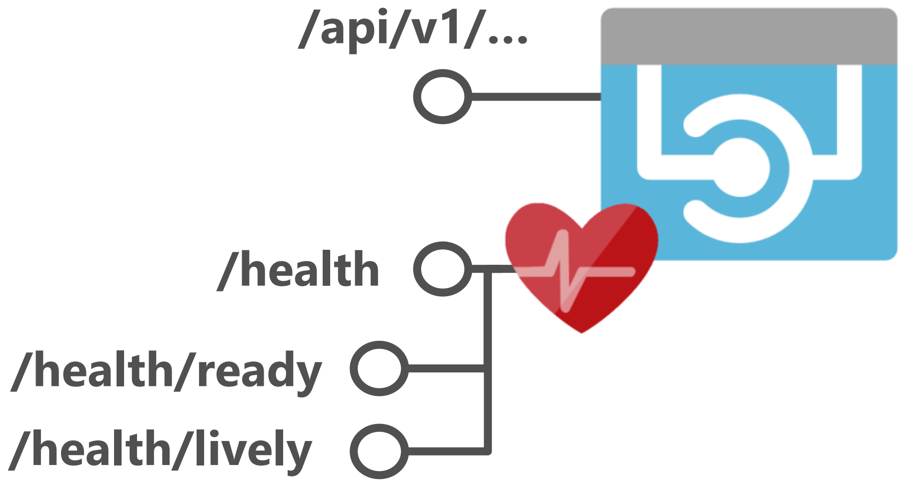
1. Add health checks with tags

```
services.AddHealthChecks()
  .AddCheck<CircuitBreakerHealthCheck>(
    "circuitbreakers",
    tags: new string[] { "ready" });
```

2. Register multiple endpoints with filter using Options predicate

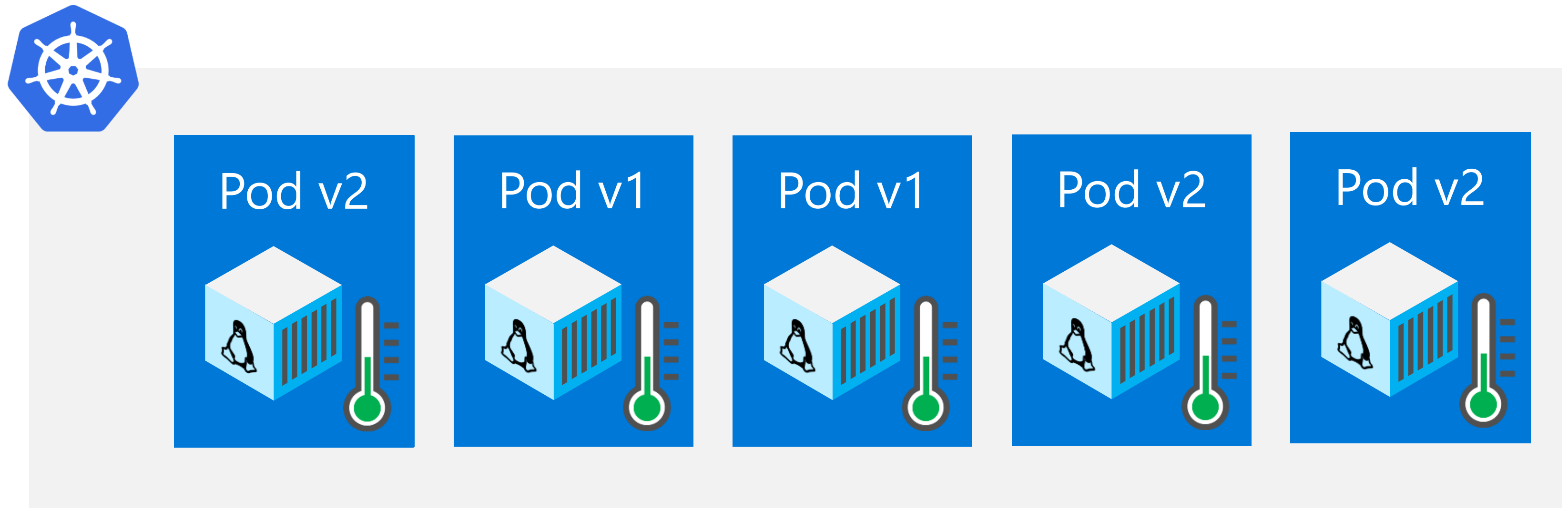
```
app.UseHealthChecks("/health/ready",
  new HealthCheckOptions() {
    Predicate = reg => reg.Tags.Contains("ready")
});
```

```
app.UseHealthChecks("/health/lively",
  new HealthCheckOptions() {
    Predicate = _ => true
});
```



Remember:
Order of registration matters

Zero downtime deployments



```
spec:
  replicas: 3
  revisionHistoryLimit: 0
  strategy:
    type: RollingUpdate
    rollingUpdate:
      maxSurge: 2
      maxUnavailable: 0
```

Original pods only taken offline after new healthy one is up

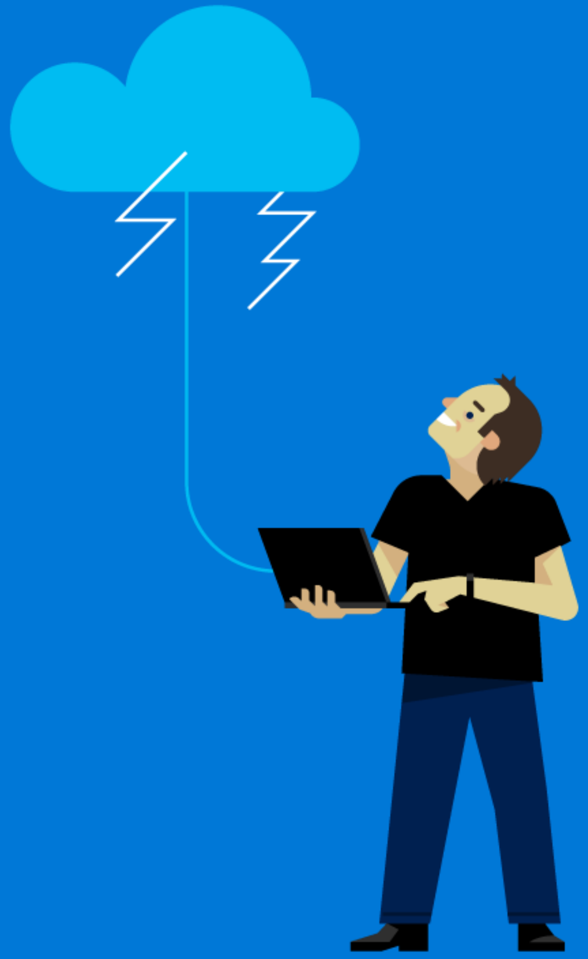
Allows roll forward upgrades: Never roll back to previous version

Demo

Readiness and liveness probes

Docker containers

Kubernetes



Securing

Expose as little detail as possible

Use different port for internal health checks

Inside a cluster ports are not exposed by default

Add authentication using middleware

```
app.UseWhen(
  ctx => ctx.User.Identity.IsAuthenticated,
  a => a.UseHealthChecks("/securehealth")
);
```

Publish instead of endpoint

Best practices

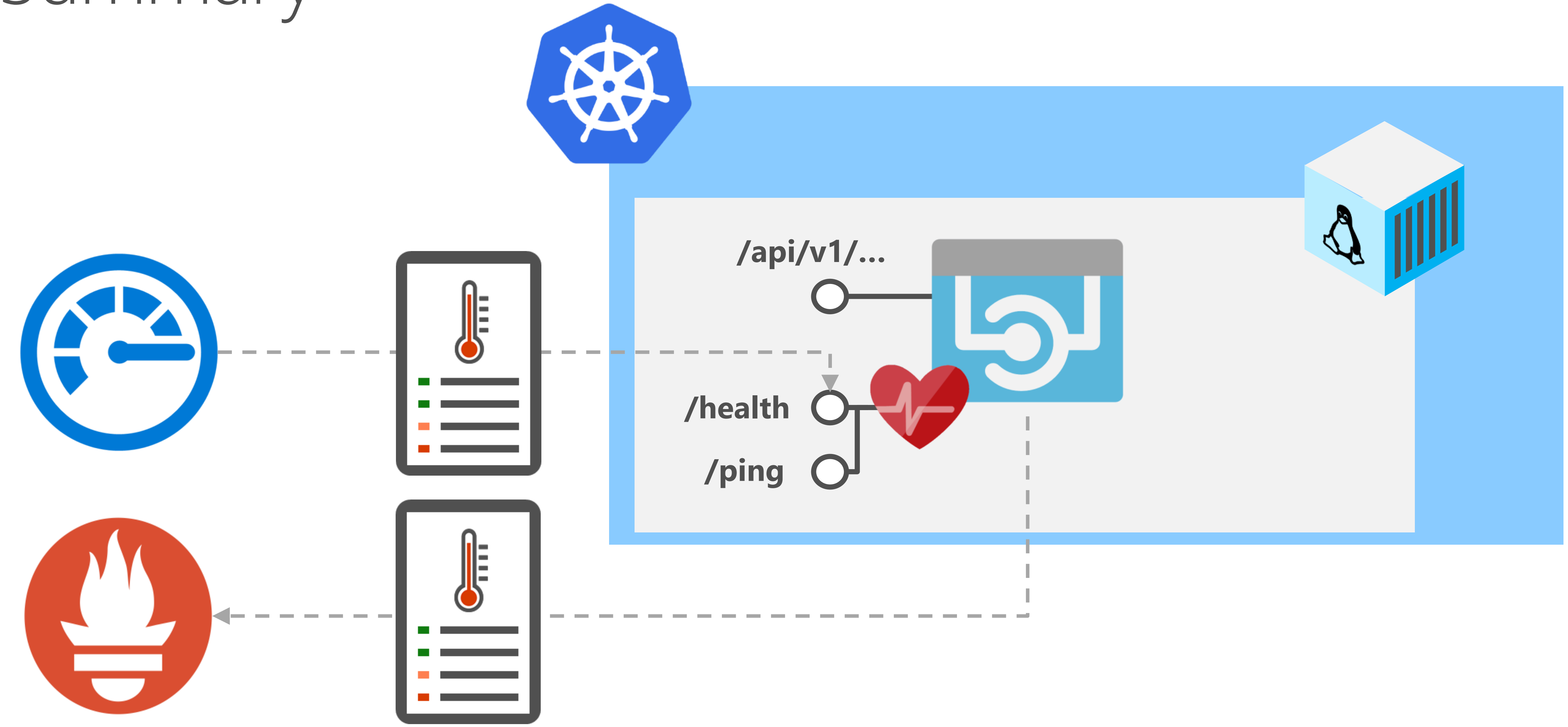
1. Assume degraded state
2. Set short timeouts on checks

Inside health checks and for publishers

For example, when connecting to external dependencies

3. Avoid complicated health checks
4. Register health check as singletons in DI

Summary



Questions and Answers

Maybe later?

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Resources

ASP.NET Core 2.2 Health monitoring

https://docs.microsoft.com/en-us/azure/architecture/patterns/health-endpoint-monitoring
https://docs.microsoft.com/en-us/aspnet/core/host-and-deploy/health-checks
https://github.com/aspnet/Diagnostics/tree/master/src

Kubernetes

https://kubernetes.io/docs/tasks/configure-pod-container/configure-liveness-readiness-probes/

BeatPulse Xalabril

https://github.com/Xabaril/AspNetCore.Diagnostics.HealthChecks

Demo source code

https://github.com/alexthissen/healthmonitoring