Microservices

An Introduction

Background

- In early days of computer science, barriers to entry in programming language were high
- Only PhD in science and computer can use these programming languages
- As at that time, nearly all use of computers required writing custom software
- In 1964, **Basic** was developed, which was a general-purpose programming language

Background

- It lowers the barriers, as now non-PhD students from other departments can also write programs
- As there was a rapid growth of computing applications in the 1960s, software became large and complex
- Computer Scientists tried to tackle the complexity of Software Systems with the ancient and proven technique: **Divide and Conquer**

Background

- In 1972, **David Parnas** introduced concept of modularity and information hiding in softwares in his paper
- **Edsger W. Dijkstra** introduced concept Separation of Concern in his paper in 1974
- Also works of others lead to the Modular Software Development in 1970's
- Modularization on the principle of decomposing a large, complex software system into "Loosely coupled, highly cohesive"

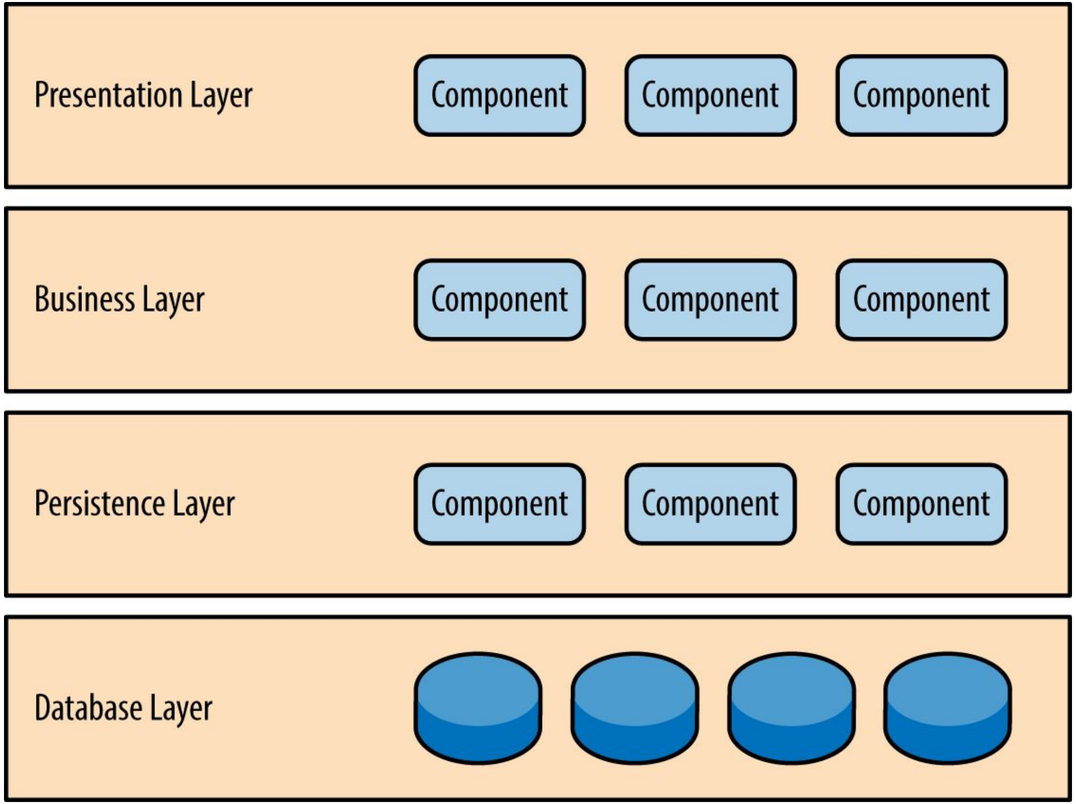
Background

- And these modules communicate via internal interfaces
- In simple means:
    - **Loosely coupled** - means the dependency between modules should be very low
    - **highly cohesive** - means that one module should focus on single or similar functionality
- With the rise of internet and web in 90’s, softwares became widespread in business applications and became even more complex and large.

Background

- Although Modularity is used to reduce the complexities of software application
- But often, it did not help as the soft Modular boundaries of software sub-systems are easy to cross and misuse
- Another Software Architecture pattern became very popular during the 1990s to develop business applications: Layered Architecture

Background


Presentation Layer
Component
Component
Component
Business Layer
Component
Component
Component
Persistence Layer
Component
Component
Component
Database Layer

Background

- Normally, a business Web Application is divided into several layers: **Presentation**, **Business**, **Database** layers
- In 1997, **Brian Foote** and **Joseph Yoder** has analyzed many Business applications and published the “**Big Ball of Mud**” papers

Background

- The paper states that most of the Business applications suffer from the following problems
  - Unregulated growth
  - Too many responsibilities
  - Lacks proper Architecture
  - Spaghetti Code
  - Make it working aka. sweeping problems under the Carpet

Background

- In the late 2000s, a Cambrian Explosion happens in the software industries due to the rise of Mobile Internet (Wifi, Smartphone) and faster network
- It was the time when softwares started to eat the world
- All types of companies like Banking, Insurance, Restaurants, Hotels, Music, Driving, etc

Background

- Companies like **Facebook**, **Twitter**, **Uber**, **Netflix**, **Spotify** came with innovative ideas, aggressive strategy, move fast approach leads to the exponential growth of their applications
- Suddenly, engineers found that Monolithic Architecture cannot handle the challenges of Modern, Fast-Paced or Web-Scale Software development

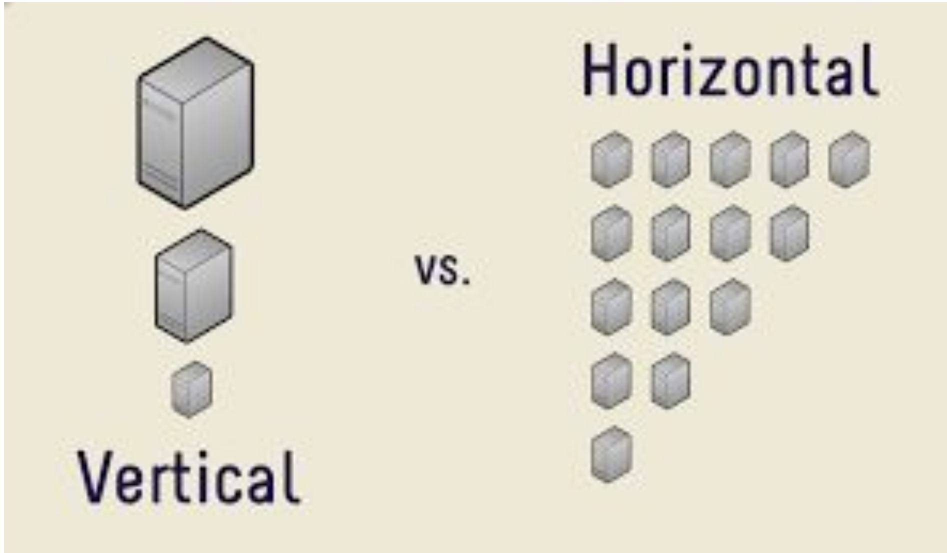
Limitations of Monolithic Architecture

Application Scaling

- As the successful Web Scale companies enjoy exponential growth
- Their softwares also need to support high horizontal scalability
- Sometimes, only a part of the software which is e.g. **CPU intensive** or **I/O intensive** needs to be scaled and handled separately (implemented with polyglot programming)
- Monolithic software works as a single unit and developed in a single programming language using a single Tech Stack

Application Scaling

- To achieve horizontal scaling, the whole application needs to be scaled
- Monolithic software only supports one programming language, it is not possible to implement one single module of it in other programming language



Development Velocity

- To shorten **time to market**, every company nowadays wants to have fast feature development
- In a large Monolithic Application, adding new feature is very slow because such a Monolithic Application gives huge Cognitive Load to the Developer
- Modules of giant Monolithic applications are tightly coupled and provide an additional challenge to add new features
- As a result, adding new features in a Monolithic application become very expensive

Development Scaling

- Companies want parallelizing development by hiring more developer for fast pace development
- However, developers cannot work independently on a Monolithic, tightly coupled code base which needs extra synchronization
- Therefore, adding more developers doesn’t produce more feature
- Similarly due to cognitive load, new hires or fresh graduates take long time to write first piece of productive code

Release Cycle

- Release cycle of large monoliths is even large; usually 6 months to 2 or 3 years
- In today's market, large release cycles can put the company under competitive disadvantages
- As during these gaps a new company can come and take away its market

Modularization

- In Monolithic Architecture, the boundary between modules are internal Interfaces
- As soon as the application grows in size, the boundary between modules starts to fall apart
- As a result, often modules in Monolithic Architecture are tightly coupled instead of being "**Loosely coupled**, **highly cohesive**"

Modernization

- Existing successful applications needed to be modernized due to many factors (e.g. taking advantage of modern Hardware, Browser, Network Bandwidth or Attract good developers)
- Modernization of Monolithic application is expensive and time-consuming
- It needs a **Big Bang modernization** of the whole application without disrupting the Service

Microservice Architecture

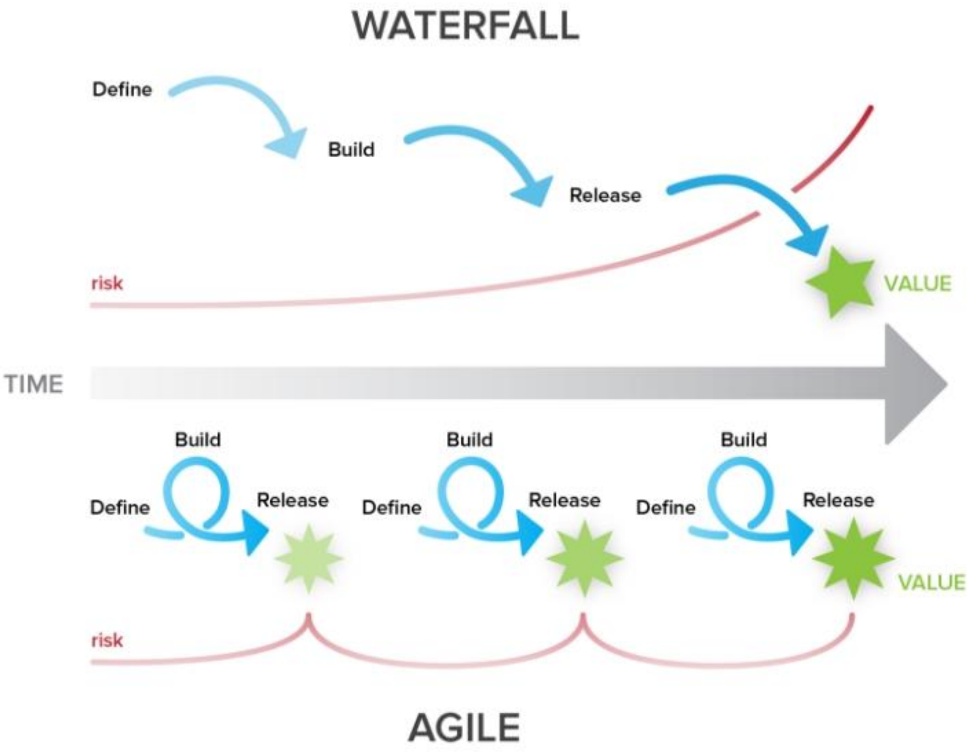
Microservice Architecture

- In the 2010s, other disruptive technologies arise which impact the Software Development landscape in a significant way
- Cloud Computing, Containerization (Docker, Kubernetes), DevOps
- Likewise some **highly productive**, **lightweight** new programming languages e.g. **Golang**, **Rust**, **Swift** comes to scenario
- Some **highly productive**, **easy to use**, **lightweight** programming language like JavaScript, Python become mainstream

Microservice Architecture

- There is a change in Software Development model also
- **Waterfall** software development model is almost discarded
- Replaced by fast, iterative, incremental Software development methodology: **Agile Software development**
- Computer Hardware also changed massively with cheaper, faster main memory and rise of **Multi-Core CPU**, **GPU**
- New Database technologies like NoSQL, **NewSQL** emerges and become mainstream

Microservice Architecture



Microservice Architecture

- To handle the complexity of modern software applications
- To take the advantages of Cloud Computing, Containerization, DevOps
- To get benefit from modern Programming languages
- To fulfill the need of **modern software development** (fast development, horizontal scaling)
- In 2012, **Microservices Architecture**; a new software architecture style arose

Microservice Architecture

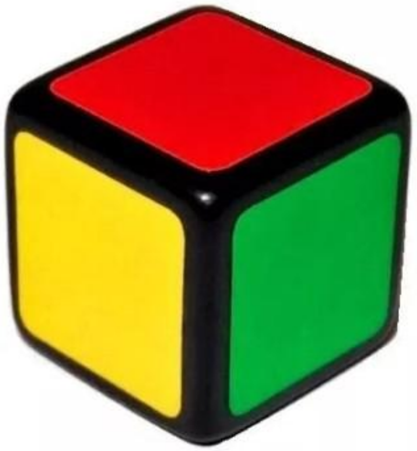
Definition :

> *“ **Microservice Architecture** is about decomposing a Software System into autonomous Units which are independently deployable and which communicates via lightweight, language agnostic way and together they fulfill the business goal. ”*

Microservice Architecture

- Microservice Architecture also uses the same technique of divide and conquer
- However, the difference between two is; a microservice can be deployed independently whereas all modules of monolith must deployed as whole

Microservice Architecture



Monolith

Modular Monolith

Microservices

Advantages of Microservices

Application Scaling

- Microservices are often Stateless
- If carefully deployed then microservices can offer horizontal scaling within seconds
- It is the high horizontal scaling which leads the tech giants to move to microservices
- Supports polyglotting; if a microservie is e.g. CPU intensive, it can be implemented in CPU optimized programming language and other microservices can be implemented in other languages

Development Velocity

- Microservices are often quite small in size
- Due to the size, adding new features in Microservices are usually faster

Development Scaling

- Microservices are autonomous and can be developed independently
- Developers/teams can work on different microservices autonomously
- Companies can hire more developers to scale development
- Due to sizes, Microservices puts small Cognitive load on new hires
- Developers take lesser time to write first line of productive code

Release Cycle

- Every microservice is independently deployable
- Resulting in the much **smaller release cycle**
- Using **CI/CD pipelines**, it is possible to give several releases per day

Modularization

- Boundary between the microservices are external Interfaces aka Physical (Network) which is hard to cross
- Correctly crafted microservices often offers the “**Loosely coupled**, **highly cohesive**” modularization

Modernization

- Microservices are loosely coupled and only communicate via language-agnostic way with each other
- A microservice can easily be replaced by a new one which can be developed using a new programming language
- Modernization in microservice architecture is **incremental** and not Big Bang

Disadvantages of Microservices

Disadvantages of Microservices

- As like anything in life, microservice architecture has also its price and a fair share of disadvantages
- It is by no means a Golden Hammer which can solve all sort of Problems in a Software Application
- There are scenarios in which moving to µservice architecture from monolithic architecture without proper consideration will leads to nightmarish condition

Design Complexity

- Monolithic Architecture often gives “One size fits for all” solution for Business applications
- But in µservice architecture, there are many solutions possible depending on the applications and use cases
- If the wrong solution is taken for wrong application size/type (e.g. put a kid's clothes on a full-grown man or vice versa), then µservice architecture is bound to fail

Design Complexity

- Also, designing μservices is challenging as there are far more moving parts compared to monoliths
- Usually, a badly designed μservice is worse than a monolith

Distributed Systems Complexity

- Microservices are distributed system; which are complex and has a unique set of challenges compared to single Machine systems
- Following problems can arise in Distributed Microservices:
    - Overall System latency is higher
    - Network failure or Individual Node failure can bring the whole system down
    - Operational complexities are higher

Operational Complexity

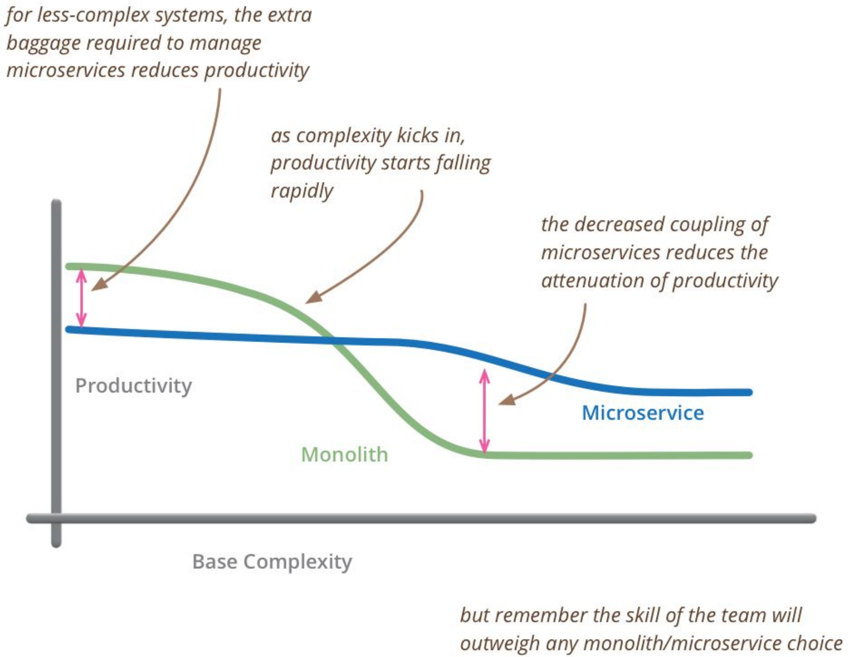
- Once the Monolithic application is decomposed into µservices, the complexity moves from source code to operations
- Simple operations like Logging, Monitoring became more complex because instead of one Systems, many more need to be handled
- Sometimes existing Logging/Monitoring tools don’t fit with µservices and new once are needed
- Tracing is also very important in µservices to measure the performance/latency of individual µservices for a Service Request

Operational Complexity

- The complete System test is likewise quite complex in µservices compared to monolithic applications

- A renowned computer scientist **Martin Flower** states :

  “ the initial Development Velocity of Microservice Architecture is lower compared to Monolithic Architecture due to the Operational Complexities ”



for less-complex systems, the extra baggage required to manage microservices reduces productivity

as complexity kicks in, productivity starts falling rapidly

the decreased coupling of microservices reduces the attenuation of productivity

but remember the skill of the team will outweigh any monolith/microservice choice

Security

- Security in software systems is that elephant in the room what everybody can see but nobody wants to talk about
- Securing one software application is hard
- Securing hundreds of µservices which are often distributed systems is quite challenging

Data Sharing and Data Consistency

- Ideally, every µservices should have its own data store
- Downside is that the µservices need to share data between themselves to fulfill the business goal
- Data consistency is another challenge
- To support consistency in the distributed databases is not recommended for two reasons:
  - It does not Scale and many Modern Data Store does not support it
  - Most of the modern NoSQL Databases only offers Eventual Consistency which needs careful design

Communication Complexities

- Microservices achieves strict modularity and development autonomy via process/network boundaries
- Downside is that the services can only communicate via the physical network which eventually leads to higher network latency

Conclusion

Conclusion

- Designing and implementing µservices architecture is challenging compared to monolithic software architecture
- Microservice architecture is by no means a silver bullet which can solve the complexity issues of all sorts of applications
- Even after different arguments, it is believed that µservices architecture is a very useful and handy tool for modern software development

Conclusion

- Specially for large Enterprises which normally develop complex softwares, µservices architecture is the only way to tackle complexity and to be competitive in the market

Resources

Link to article :

https://towardsdatascience.com/microservice-architecture-a-brief-overview-and-why-you-should-use-it-in-your-next-project-a17b6e19adfd

Summary