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"

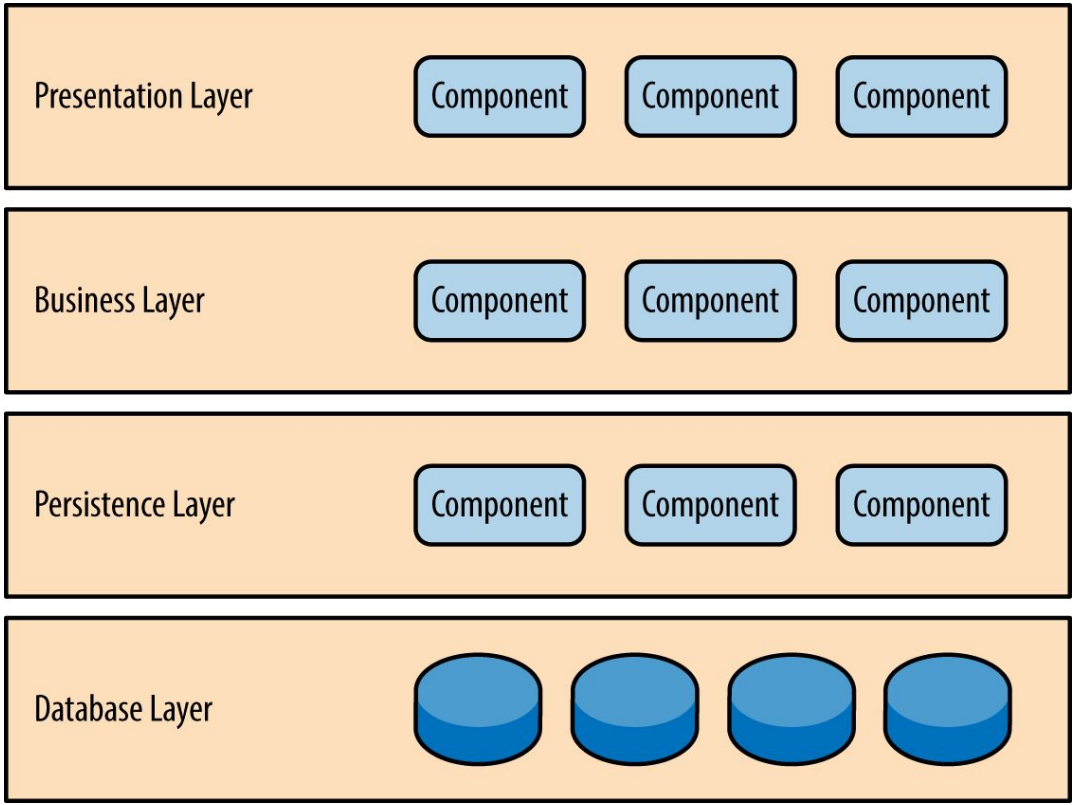
Background

- 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

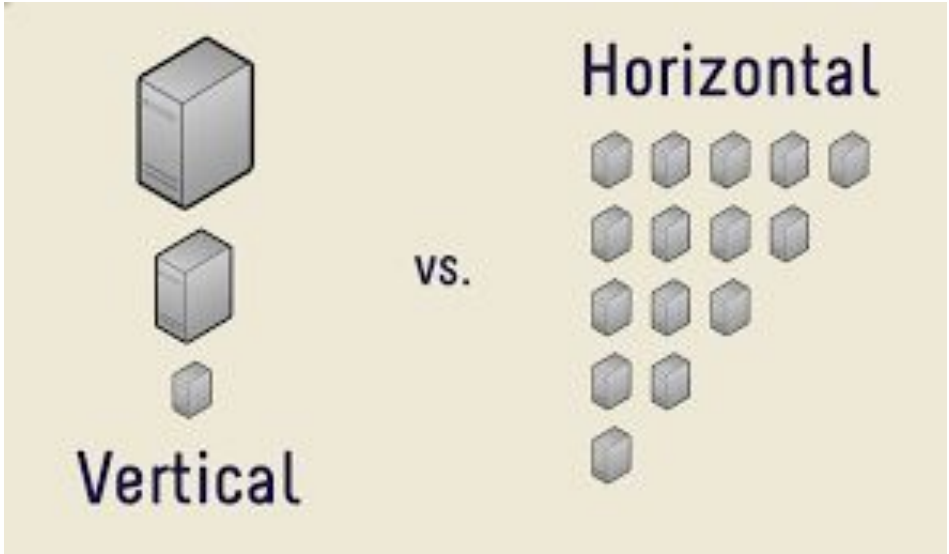
Limitations of Monolithic Architecture

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

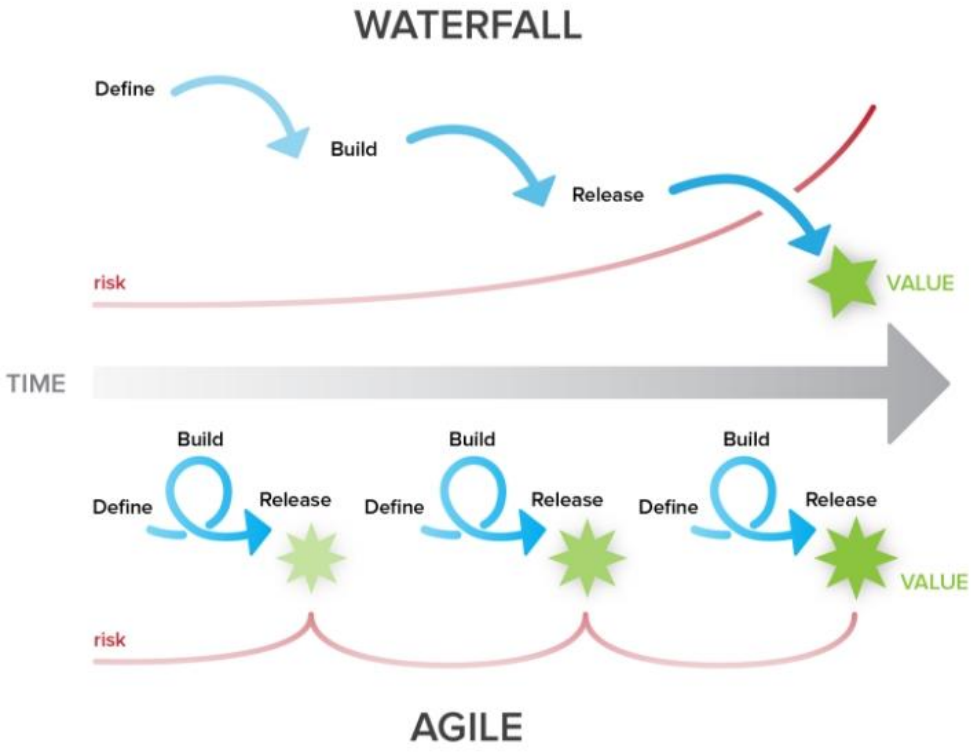
Microservice Architecture

- 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

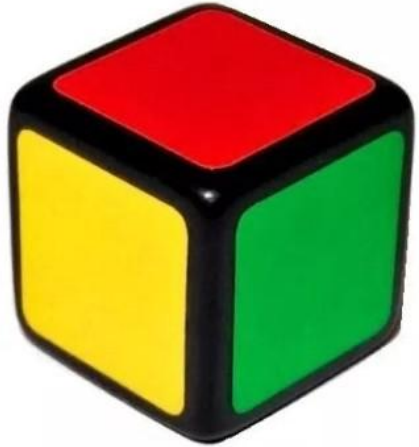
Definition :

> " ***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

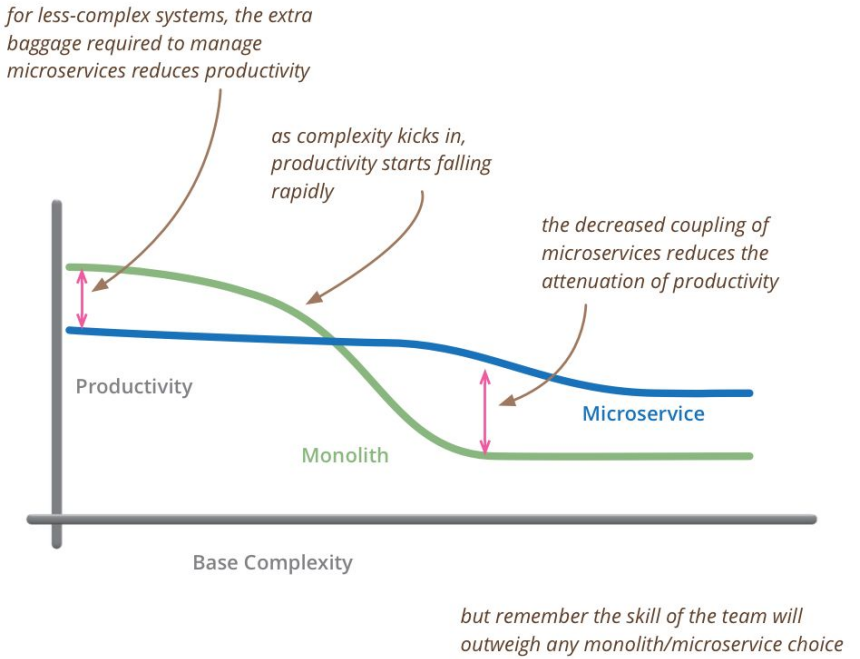
- Once the Monolithic application is decomposed into μservices, the complexity moves from source code to operations
- Simple operations like Logging, Monitoring became more complex because instead of one Systems, many more need to be handled
- Sometimes existing Logging/Monitoring tools don't fit with 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* "



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


PRESIDENTIAL
INITIATIVE
ARTIFICIAL INTELLIGENCE AND COMPUTING

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

Feedback:

https://forms.gle/PYnNbFfssdgWfCfX6

Summary