node-java-golang

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does nodejs spawns new threads or process for every new HTTP request?

Node.js is built on an event-driven, non-blocking I/O model that uses a single-threaded event loop to handle asynchronous operations. This means that by default, Node.js runs in a single thread and does not spawn new threads or processes for every new HTTP request. Instead, it uses an event loop to efficiently handle multiple concurrent requests.

When an HTTP request is received, Node.js processes it asynchronously without blocking the main thread. If there are I/O operations (such as reading from files, making network requests, etc.), Node.js delegates those operations to its underlying asynchronous APIs, allowing the main thread to continue handling other tasks while waiting for the I/O to complete. Once the I/O operation is finished, a callback is triggered, and the event loop processes it.

This architecture allows Node.js to handle a large number of concurrent connections efficiently without the overhead of creating new threads or processes for each request. It is particularly suited for applications that involve I/O-heavy operations, such as web servers, because it can handle many connections simultaneously while keeping resource usage relatively low.

It's worth noting that while Node.js itself uses a single thread for event handling, some operations in Node.js, like certain native modules or worker threads, can utilize additional threads or processes when explicitly programmed to do so. However, the core event loop and HTTP request handling remain single-threaded.

http.get("/something/all",(req, res)=>{ // heavly I/O call or db call db.query("SELECT * ....", function(result){ .... for(i=0;i<result.length;i++){ // loop through and build result } response.end(modifiedResult) }) }) Take this example. So basically when 50 HTTP requests are made to this API, how does node handle this

In the scenario you've described, where 50 HTTP requests are made to an API that involves heavy I/O calls or database calls, Node.js uses its event-driven, non-blocking architecture to handle these requests efficiently. Here's how it would work:

1. **Request Reception**: When a request is received, the event loop in Node.js triggers the corresponding callback (the function you provided in `http.get`). This callback is executed asynchronously, without blocking the main thread, allowing Node.js to continue processing other events.
2. **I/O Operations**: Within the callback, you have an I/O-intensive operation (database query). Node.js delegates this operation to its asynchronous I/O APIs. While waiting for the database query to complete, Node.js doesn't just sit idle; it continues processing other events and incoming requests.
3. **Callback Execution**: When the database query is finished, its callback function is triggered. This callback function processes the results of the query.
4. **Response Building**: Within the database query's callback, you're building a response by looping through the results and modifying them. This is also done asynchronously, and Node.js continues processing other events during this time.
5. **Response Sending**: Once the response is built, you use the `response.end()` method to send the modified result to the client.

Since Node.js's event loop allows it to handle multiple events concurrently without blocking the main thread, it can effectively manage these 50 HTTP requests without creating a separate thread or process for each request. While some requests might be waiting for I/O operations to complete, Node.js can still process other requests and events, making efficient use of the available resources.

It's important to note that if the I/O operations or database queries are slow, they can potentially become a bottleneck, impacting the overall throughput of your server. To mitigate this, you might consider strategies like connection pooling, optimizing database queries, and making use of asynchronous programming patterns to ensure that your application remains responsive and efficient even under heavy load.

how it processes 50 concurrent connection if it doesnot spawn new threads or process?

Node.js is designed to handle a large number of concurrent connections without the need to spawn new threads or processes. It achieves this through its event-driven, non-blocking architecture. Here's how it processes 50 concurrent connections without creating new threads or processes:

1. **Single Thread**: Node.js operates in a single thread. This thread is responsible for managing the event loop and executing JavaScript code.

2. **Event Loop**: When multiple HTTP requests come in, Node.js's event loop efficiently manages these requests. Each incoming request is treated as an event.

3. **Non-Blocking I/O**: When a request involves I/O operations (such as reading from a file or making a database query), Node.js delegates these operations to its underlying asynchronous APIs. While waiting for I/O to complete, the main thread is not blocked and can continue processing other events.

4. **Callbacks and Asynchronous Code**: The asynchronous nature of Node.js allows it to efficiently switch between different tasks without waiting for one to complete before moving on to the next. Callback functions are used to handle the results of I/O operations once they're finished.

5. **Concurrency**: While one request's I/O operation is in progress, Node.js can continue processing other requests that are either awaiting I/O or performing non-blocking operations. This concurrency is managed by the event loop, which prioritizes tasks based on their readiness.

6. **Scaling**: Node.js leverages the operating system's underlying asynchronous I/O capabilities, which are often implemented using mechanisms like epoll on Linux. This allows Node.js to handle a high number of connections concurrently.

7. **Resource Efficiency**: By avoiding the overhead of creating new threads or processes for each request, Node.js maintains a low memory footprint. This makes it suitable for applications that require high scalability and efficient use of resources.

Overall, Node.js's ability to handle multiple concurrent connections is based on its event-driven, non-blocking architecture, which allows it to efficiently manage I/O operations and callbacks without the need to spawn new threads or processes. This approach can result in high throughput and responsiveness for applications, especially those that involve I/O-intensive tasks like web servers.

explain me the scenarion where two req comes in at the same time. Assume there is no I/o operations under that req callback u are saying it'll not spawn anything then how on earth it'll handle multiple request paralley.. doesn't the other requests have to wait

Certainly, let's go through a scenario where two requests come in at the same time, assuming there are no I/O operations directly within the request callback. In this scenario, we'll focus on the basic event loop behavior of Node.js.

1. **Two Requests Simultaneously**: Let's say two HTTP requests, Request A and Request B, arrive at the server at the same time.

2. **Event Loop**: Node.js processes these requests within its single-threaded event loop. The event loop manages the execution of various tasks, and it maintains a queue of pending tasks to be executed.

3. **Callbacks Execution**: Both Request A and Request B have corresponding callbacks associated with them. These callbacks are executed in the order they were received.

4. **Non-Blocking Nature**: If there are no blocking operations or significant computational tasks within the callbacks, Node.js can quickly execute both callbacks without having to wait for one to finish before starting the other.

5. **Concurrency**: Even though Node.js operates in a single thread, it can switch between executing tasks rapidly. When Request A's callback is executing, and it doesn't block the event loop, Node.js can quickly move on to execute Request B's callback.

6. **Time Sharing**: Node.js's fast context switching allows it to time-share between the callbacks, making it seem like both requests are being processed concurrently. While they are being processed one after the other in the same thread, the rapid context switching creates the illusion of parallel processing.

7. **Response**: Once both callbacks are executed, the respective responses for Request A and Request B are sent back to their corresponding clients.

In this scenario, Node.js leverages its ability to quickly switch between tasks and execute callbacks in a non-blocking manner. This allows it to provide concurrency and handle multiple requests seemingly in parallel, even though it's happening within a single thread. The absence of blocking operations or significant computational tasks within the callbacks ensures that the event loop can keep moving forward without getting stalled by any single request's processing.

It's important to note that while this approach provides concurrency and efficient handling of multiple requests, it might not be suitable for all scenarios. Node.js's strength lies in its ability to handle I/O-intensive operations concurrently. If there were CPU-bound tasks within the callbacks, they could still block the event loop and impact the overall responsiveness of the server.

now explain this same scenarion in case of a GoLang HTTP server

In a GoLang HTTP server, the concurrency model is different from Node.js's event-driven architecture. GoLang's concurrency is built around lightweight threads called "goroutines" and a synchronization mechanism called channels. Let's walk through the scenario where two requests come in at the same time in a GoLang HTTP server:

1. **Two Requests Simultaneously**: Similar to the Node.js scenario, two HTTP requests, Request A and Request B, arrive at the GoLang server at the same time.

2. **Goroutines**: In GoLang, each incoming request is typically handled within its own goroutine. Goroutines are lightweight threads that are managed by the Go runtime. Unlike traditional threads, goroutines have a much smaller memory footprint and are more efficient to create and manage.

3. **Goroutine Creation**: When Request A comes in, a new goroutine is spawned to handle its processing. Simultaneously, when Request B arrives, another goroutine is created to handle its processing. These two goroutines can be created quickly and efficiently due to their lightweight nature.

4. **Concurrency**: GoLang's runtime scheduler manages the execution of these goroutines across the available CPU cores. The Go runtime employs a technique called "multiplexing" to efficiently switch between active goroutines, allowing them to run concurrently.

5. **Non-Blocking I/O**: If there are I/O operations involved in the processing of the requests (like reading from files or making network calls), the goroutines can yield control to the scheduler while waiting for I/O to complete. This non-blocking behavior allows other goroutines to execute while one is waiting.

6. **Synchronization**: If there are shared resources that need coordination, GoLang provides channels for synchronization. Goroutines can communicate with each other using channels, ensuring safe concurrent access to data.

7. **Response**: Once the processing for Request A and Request B is complete, and if there are response actions to be taken, the respective responses are sent back to the clients.

In this scenario, GoLang's goroutines provide a more traditional multithreading-like concurrency model. Each incoming request can be handled within its own goroutine, which allows the GoLang server to efficiently utilize available CPU cores. The lightweight nature of goroutines, combined with the runtime's scheduling and synchronization mechanisms, enables effective parallelism without creating heavy overhead.

It's important to note that both Node.js and GoLang have their strengths and trade-offs when it comes to handling concurrent connections. Node.js's event-driven model is well-suited for I/O-intensive operations, while GoLang's goroutines are designed to efficiently manage concurrency and parallelism across multiple CPU cores. The choice between them depends on the specific requirements of your application.

means in GoLang if i have two incoming request (assuming I've a dual core cpu). then it means it'll spawn two go routines, and if i have a db call defined. Then those two routiones will parallely call the DB then it means those individual goroutine will be blocked in their own space right? but since they are being handled parallely so its non-io blocking right?

Yes, your understanding is correct. In a GoLang server running on a dual-core CPU, if you have two incoming requests, GoLang will indeed spawn two goroutines to handle these requests. If each of these requests involves a database call, the goroutines can run the database calls concurrently and in parallel, effectively utilizing the available CPU cores. Here's how this works:

1. **Goroutine Creation**: When two incoming requests arrive simultaneously, GoLang's server will create two separate goroutines to handle them.

2. **Concurrency and Parallelism**: Since your CPU has two cores, these two goroutines can run in parallel on the two available cores. This allows the server to efficiently utilize the processing power of the CPU.

3. **Database Call**: If the requests involve a database call, each goroutine can initiate its own database query. These database queries can be executed concurrently, thanks to the parallelism provided by the multiple CPU cores.

4. **Non-Blocking I/O**: While the database queries are in progress, the goroutines are not blocked waiting for the I/O to complete. Instead, they yield control to the Go runtime scheduler, allowing other goroutines to run. This ensures that the server remains responsive and can continue processing other requests or performing other tasks while waiting for I/O operations to finish.

5. **Synchronization and Response**: If there's shared data that needs coordination between the goroutines, GoLang provides synchronization mechanisms such as channels. Once the database queries complete and the responses are ready, the goroutines can handle the responses and send them back to the respective clients.

In this scenario, even though the individual goroutines may wait for the database I/O to complete, their non-blocking behavior ensures that they don't monopolize CPU resources. Other goroutines can continue running in the meantime, providing concurrency and parallelism.

GoLang's lightweight goroutines and efficient concurrency model make it well-suited for applications that require high parallelism and concurrent I/O operations, like web servers that handle multiple requests simultaneously.

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on point number 4, clear me out.. in OS theories 1) if thread is blocked then entire process if blocked right? 2) by yeild u mean the goroutine here is not blocked but authority is given to goruntime (or go's scheduler), its kind of illusion that the thread is still up (or online), other wise the process will be blocked

Certainly, let's clarify your questions:

1. **Thread Blocking and Process Blocking**: In traditional operating systems, if a thread within a process is blocked (for example, waiting for I/O to complete), it can potentially block the entire process, preventing other threads within the same process from executing. This is because threads within the same process share the same memory space and resources, and blocking one thread can have a cascading effect on the entire process.

2. **Yielding and Goroutine Execution**: In GoLang, when we talk about yielding, we mean that a goroutine voluntarily gives up control to the Go runtime scheduler. The Go runtime scheduler efficiently schedules and switches between active goroutines, allowing them to run concurrently. When a goroutine encounters a point where it needs to wait for something (e.g., an I/O operation like a database query), it can yield control to the scheduler.

   While a goroutine is yielding, the Go runtime scheduler can schedule other runnable goroutines to run on the available CPU cores. This is what allows for true parallelism and concurrency within a single GoLang process. It's not an illusion of a thread being "online" while blocked; instead, it's a way to ensure that the CPU is effectively utilized by allowing other non-blocking goroutines to execute in parallel.

   Importantly, while a goroutine is yielding due to an I/O operation or other blocking event, the Go runtime scheduler can continue executing other runnable goroutines, ensuring that the entire process is not blocked. This concurrency and parallelism are key features of GoLang's goroutines and scheduler.

In summary, GoLang's concurrency model with goroutines and the scheduler is designed to efficiently manage blocked and non-blocked goroutines, allowing for high parallelism and responsiveness. This is different from traditional thread-based approaches, where blocking one thread can have more significant consequences on the entire process.

now explain this same scenarion in case of a Java HTTP server two incoming request at the same time with some I/O operations after 10lines and at 11th line there is some I/O call.

Sure, let's go through the scenario of handling two incoming requests simultaneously in a Java HTTP server with some I/O operations.

1. **Two Requests Simultaneously**: Two HTTP requests, Request A and Request B, arrive at the Java HTTP server at the same time.

2. **Thread-Per-Request Model**: In many traditional Java HTTP server implementations, a common approach is to use a thread-per-request model. This means that a new thread is created for each incoming request to handle its processing.

3. **Thread Creation**: When Request A comes in, a new thread is created to handle it. Simultaneously, when Request B arrives, another thread is created to handle its processing. Each thread operates independently.

4. **I/O Operations**: As you mentioned, after 10 lines in the code of each request, there are I/O operations. These I/O operations could be reading from files, making network requests, or database queries.

5. **Blocking Behavior**: When an I/O operation occurs, the thread that is currently executing the request is blocked while waiting for the I/O operation to complete. This blocking behavior means that if an I/O operation is slow, the thread will be held up, unable to handle other requests during that time.

6. **Concurrency and Blocking Impact**: If the I/O operations after the 10th line are quick, then the server can handle both requests efficiently. However, if the I/O operations are slow or if they involve waiting for external resources, it can impact the server's ability to handle other incoming requests concurrently.

7. **Additional I/O at 11th Line**: If there's another I/O operation after the 11th line, this operation will further block the thread currently handling the request.

8. **Resource Management**: In a thread-per-request model, it's important to manage the number of threads carefully. Creating too many threads can lead to excessive memory usage and resource contention. Some server implementations use thread pools to manage and reuse threads, which can help mitigate resource-related issues.

9. **Response Handling**: Once the I/O operations are complete and the responses are ready, the respective threads can send the responses back to the clients.

In this scenario, Java's thread-per-request model provides concurrency by using multiple threads to handle multiple requests concurrently. However, the blocking nature of I/O operations can impact the overall efficiency and responsiveness of the server. Proper thread management, including using thread pools, can help mitigate some of these issues, but the potential for resource contention and blocking remains a consideration.

It's worth noting that modern Java frameworks and libraries, such as those built on top of the Reactor or Netty libraries, offer more advanced non-blocking and event-driven approaches to handle I/O operations efficiently, similar to what Node.js provides. These frameworks can help mitigate some of the challenges associated with traditional thread-per-request models.

i still dont understand one thing here... since both the request came at the same time and two threads are created. say T1 and T2 assume we have multi-core CPU, so these threads will be processed parallely. now suppose T1 hits some blocking I/o operation, if it waits means T1 is in blocked state right? coming to Operating System Concept.. if a thread spawned from some process is blocked then all the other threads are blocked right? so in this case since T1 is blocked/or waiting for some I/o operation to complete... does it mean T2 is also blocked because of this.. assuming T2's code dont contain any blocking I/o. after T1 gets into readystate again, t1 and t2 again starts excuting parallely. Am i correct?

You're almost correct, but there's a key distinction to be made between threads blocking at the application level and threads blocking at the operating system level.

In a multi-threaded environment like Java's thread-per-request model:

1. **Application-Level Blocking**: When a thread (T1) encounters a blocking I/O operation, it becomes blocked at the application level. This means that within the application's code, that specific thread is waiting for the I/O operation to complete. During this time, other threads (like T2) can continue executing their code, even if they're part of the same process.

2. **Operating System-Level Blocking**: At the operating system level, threads are typically managed individually. If one thread (T1) within a process becomes blocked at the application level, it does not necessarily block all other threads (like T2) within the same process. The operating system's thread scheduler can continue allocating CPU time to other runnable threads in the same process.

So, in your scenario:

- When T1 hits a blocking I/O operation, it will be waiting for that operation to complete at the application level. However, this does not automatically block other threads, such as T2, at the operating system level.

- T2 can continue to execute as long as it's not waiting for any blocking I/O operations or synchronization mechanisms that could cause it to block.

- Once the blocking I/O operation in T1 completes, T1 becomes runnable again, and the thread scheduler can allocate CPU time to it.

In summary, application-level blocking doesn't necessarily imply operating system-level blocking for all threads within the same process. Other threads can continue running, even if one thread is waiting for a blocking operation to complete at the application level. This separation allows for concurrency and parallelism within the same process.

when does process get blocked.. give me an example.. where thread gets blocked at OS level and all the other thread gets blocked

A process can get blocked at the operating system level when an external event occurs that affects the entire process's ability to execute, such as waiting for a shared resource, synchronization, or other operating system-related conditions. Let's go through an example where threads within a process get blocked at the operating system level:

Example: Mutex Lock Contention

Imagine a scenario where a process has multiple threads, and these threads share a common resource protected by a mutex (mutual exclusion) lock. The mutex ensures that only one thread can access the shared resource at a time to prevent data races.

1. **Thread Creation**: The process has three threads: Thread A, Thread B, and Thread C.

2. **Mutex Lock**: All threads need to acquire a mutex lock before accessing a shared resource to ensure exclusive access.

3. **Thread Execution**:

    - Thread A tries to acquire the mutex lock and succeeds. It starts performing its work using the shared resource.
    - Thread B and Thread C are also running concurrently and want to access the same shared resource.
4. **Blocking Condition**: If Thread B and Thread C attempt to acquire the mutex lock while Thread A holds it, they can't proceed. The mutex lock is in use.

5. **Blocked Threads**: In this case, Thread B and Thread C are blocked at the operating system level. The operating system suspends their execution and places them in a "blocked" state because they cannot make progress until the mutex lock is released by Thread A.

6. **Unblocking**: Once Thread A releases the mutex lock, one of the blocked threads (either Thread B or Thread C) can acquire the lock and continue executing. The other blocked thread remains in the blocked state until it gets a chance to acquire the lock.

In this scenario, all the threads within the process get blocked at the operating system level when contending for a shared resource that is protected by a mutex lock. This is a synchronization issue that occurs at the operating system level and impacts the entire process's execution.

It's important to note that the blocking behavior in this example happens due to the operating system's mechanisms for managing threads and synchronization. Threads within the same process can block at the operating system level when they are competing for shared resources or synchronization primitives like locks.

can the whole process get blocked if one thread performs some I/O?

Yes, in some cases, the entire process can get blocked if one thread performs certain types of I/O operations. This situation usually arises when the I/O operation is of a nature that requires the entire process to wait until the operation is completed.

For example, if a thread within a process initiates an I/O operation that involves waiting for external resources, and if this I/O operation is synchronous (blocking), then the thread will be blocked, and consequently, the entire process may be blocked as well. This is because in many traditional threading models, when one thread is blocked due to a synchronous I/O operation, it might cause the entire process to wait.

Here's how this can happen:

1. **Blocking I/O Operation**: Consider a thread (Thread A) in a process that performs a blocking I/O operation, such as reading from a file or waiting for a network response.

2. **Synchronous Blocking**: If the I/O operation is synchronous, Thread A will be blocked until the operation completes. During this time, Thread A is essentially inactive and cannot perform any other tasks.

3. **Process-Level Blocking**: If the process's design or threading model does not allow other threads to continue executing independently of Thread A's blocking operation, then the entire process might become blocked. This is because the process is effectively waiting for Thread A's I/O operation to complete.

4. **Impact on Other Threads**: Any other threads within the same process may also be prevented from making progress if the process-level blocking mechanism is in place. This can lead to reduced concurrency and responsiveness in the application.

It's important to note that modern programming practices often aim to minimize or avoid such scenarios by using asynchronous I/O operations, non-blocking techniques, and event-driven architectures. Languages and frameworks that offer asynchronous programming models allow one thread to initiate I/O operations without blocking, enabling other threads or tasks to continue executing concurrently. This approach helps prevent process-level blocking and improves overall application responsiveness.

hmm.. then how java and golang defers in handling http? you said that if we have two req at same time then 2 threads will be spawned, say t1 and t2 and if t1 performs some i/o operation then t1 gets blocked right? but t2 keep running itself parallely (assuming we have multi-core cpu). how it differs from golang. Also take another scenario.. if t1 and t2 ask for some i/o operation at the same time then both will get blocked... right? because they are waiting for io req to complete.How this is differenct in case of golang?

Java and GoLang handle HTTP requests in different ways due to their concurrency models. Let's compare the scenarios you mentioned for both languages:

Scenario 1: Handling Concurrent Requests with Blocking I/O

In Java:

1. When two requests come in simultaneously, two threads (T1 and T2) are spawned to handle them.
2. If T1 performs a blocking I/O operation, it gets blocked. However, T2 can continue running because Java's thread-per-request model allows concurrency.
3. Java's thread-per-request approach can be less efficient in terms of resource utilization compared to GoLang's goroutines due to the overhead of creating and managing threads.

In GoLang:

1. When two requests come in simultaneously, GoLang's goroutines are used to handle them.
2. If one goroutine performs blocking I/O, it gets suspended, but other goroutines can continue running since the Go runtime's scheduler can manage their execution.
3. GoLang's lightweight goroutines and efficient scheduler enable better concurrency and resource utilization compared to the traditional Java thread-per-request model.

Scenario 2: Multiple Threads Blocking on I/O

In Java:

1. If multiple threads (T1 and T2) simultaneously request blocking I/O operations (e.g., file read) at the same time, both threads can get blocked and wait for the I/O operations to complete.

2. If these threads belong to different processes, they won't necessarily block each other, but they might still experience delays due to contention for the same resources.

In GoLang:

1. If multiple goroutines request blocking I/O operations at the same time, such as making network requests, they can all block while waiting for I/O to complete.
2. However, GoLang's goroutines don't map directly to OS threads; they're managed by the Go runtime. The Go runtime's scheduler can efficiently handle blocking I/O situations and switch to other runnable goroutines while waiting.

The key difference between Java and GoLang lies in how they manage concurrency and blocking situations. GoLang's lightweight goroutines and scheduler are designed to handle blocking I/O and concurrency efficiently, making it easier to write scalable and responsive applications. Java's thread-based approach can lead to better parallelism when I/O operations aren't involved but might have higher resource overhead and less efficient handling of blocking scenarios compared to GoLang's goroutines.

If these threads belong to different processes, they won't necessarily block each other, but they might still experience delays due to contention for the same resources explain this under scenario2, under java, point 2

I apologize for any confusion caused. I want to clarify that when I mentioned "different processes" in the context of Java's thread behavior, I misspoke. Threads within the same process are the ones that can potentially block each other or experience contention for shared resources. Threads from different processes are isolated from each other by the operating system and do not directly impact each other's execution.

Let's revisit scenario 2 and clarify how it applies to threads within the same process in Java:

Scenario 2: Multiple Threads Blocking on I/O (Corrected)

In Java:

1. If multiple threads (T1 and T2) within the same process simultaneously request blocking I/O operations (such as file reads or database queries), they can potentially block each other.
2. Threads within the same process share the same memory space and resources. If one thread is blocked due to a blocking I/O operation, it may prevent other threads from making progress, especially if they are contending for the same shared resources.

To correct my previous response, threads from different processes (belonging to different Java processes or different applications) are isolated from each other by the operating system's memory protection mechanisms. Therefore, threads from different processes won't directly block each other or experience contention for shared resources. They operate independently in their respective process contexts.

I apologize for any confusion caused by my earlier response, and I appreciate your patience in seeking accurate information.

under scenario2, under java, point 2 " it may prevent other threads from making progress" because java uses OS threads right? so its basically thread gets blocked at OS level and all the other threads within the same process gets blocked due to this? correect? in case of GoLang since instead of raw threads go uses goroutines which is essentially handled by go scheduler and manages goroutine ..like which goroutine need to be spawned at OS level. right?

Yes, you are correct in your understanding.

Java Scenario 2 (Corrected):

In Java, when multiple threads within the same process perform blocking I/O operations, they can indeed block each other at the operating system level. This is because Java threads map directly to OS threads (native threads) in many Java implementations.

If one thread within the process blocks due to a blocking I/O operation, it can potentially cause other threads in the same process to be blocked as well. This can lead to a situation known as thread contention, where threads compete for limited resources (such as CPU time or synchronization primitives like locks) and can experience delays.

GoLang Scenario 2:

In GoLang, the situation is different due to its concurrency model. GoLang uses goroutines, which are not directly mapped to OS threads. Instead, goroutines are managed by the Go runtime's scheduler, which multiplexes a relatively small number of OS threads to execute many goroutines. This allows for highly efficient concurrency and resource management.

If a goroutine in GoLang performs a blocking operation, it doesn't necessarily block an OS thread, which would cause the whole process to block. Instead, the Go runtime's scheduler can suspend the blocked goroutine and switch to other runnable goroutines. This allows other goroutines to continue executing, providing better concurrency and responsiveness.

In summary:

- In Java, when a thread blocks, it's likely an OS thread, and blocking can potentially affect other threads within the same process due to resource contention.
- In GoLang, when a goroutine blocks, the Go runtime's scheduler can manage the situation more efficiently, allowing other goroutines to continue running, providing better parallelism and responsiveness.

ok so means golang is Non-I/o blocking right? similar arch to nodejs but multi-threaded

Yes, you're correct. GoLang, like Node.js, is designed to be non-blocking and efficient in handling I/O operations. However, the underlying concurrency model and architecture differ between the two languages.

1. **Non-Blocking I/O**: Both GoLang and Node.js use non-blocking I/O techniques to handle I/O operations without blocking the main execution thread. This allows them to efficiently manage multiple concurrent connections and I/O-bound operations without waiting for one operation to complete before moving on to the next.

2. **Concurrency Model**:

    - **Node.js**: Node.js uses an event-driven, single-threaded architecture with an event loop to handle asynchronous operations and concurrency. It doesn't create new threads for each request and focuses on handling many connections with minimal resource overhead.
    - **GoLang**: GoLang uses a concurrency model based on goroutines and a scheduler. Goroutines are lightweight and managed by the Go runtime. The scheduler multiplexes a small number of OS threads to handle many goroutines, enabling high parallelism and efficient concurrency.

Both GoLang and Node.js offer similar benefits of non-blocking I/O, which makes them well-suited for I/O-intensive applications like web servers and network services.

However, GoLang's architecture allows for true parallelism on multi-core systems, thanks to its goroutines and scheduler. This can lead to more efficient utilization of CPU resources compared to Node.js, which operates in a single-threaded event loop. Additionally, GoLang's standard library provides robust support for concurrency through features like channels, which simplify synchronization between goroutines.

In summary, GoLang is non-blocking, provides efficient concurrency, and can achieve true parallelism on multi-core systems, making it a strong contender for applications requiring both I/O and CPU-bound tasks.

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ok so it means, assuming we are not using any non-io blocking lib in java.. when we create two threads (assuming we have multicore cpu), those two threads will run parallely.. if t1 has to perform some I/O operation it'll get blocked. (considering java usese Native OS threads), t2 will also get blocked? (here t2 dont have to perform any i/o operation) but in previous responses... u said t1 blocked in application level, so it'll not affect t2's excution and it'll keep running parallely

I apologize for any confusion caused by my previous responses. I'll clarify the situation regarding blocking and threads in Java.

Blocking and Threads in Java:

When it comes to traditional Java threads and blocking I/O operations, the behavior can vary based on the type of I/O operation and the synchronization mechanisms used. Here's a more accurate explanation:

1. **Blocking I/O and Threads**:
    - In Java, if a thread (T1) within a process performs a blocking I/O operation (e.g., reading from a file), T1 will indeed be blocked until the I/O operation completes. This means that T1 will not be able to execute any further code until the I/O operation finishes.
    - If another thread (T2) in the same process does not perform any blocking I/O operations, it can continue running, even if T1 is blocked due to I/O.
2. **Parallel Execution**:
    - If the CPU has multiple cores, and both T1 and T2 are running on separate cores, T2 can continue executing independently of T1 being blocked.
    - This is due to the nature of multi-core CPUs, which allow multiple threads to run in parallel on different cores.
3. **Resource Contention**:
    - However, if T1 and T2 are contending for the same shared resources, such as synchronization locks, then the blocking behavior of T1 can indirectly impact T2. For instance, if T2 needs to access a resource that T1 is holding a lock on, T2 might have to wait until T1 releases the lock.
    - This is not the case for all blocking I/O operations. For example, if T1 is blocked waiting for an I/O operation to complete, and T2 doesn't require access to the same resource, T2 can still continue executing without being directly affected by T1's blocking state.

In summary, Java's thread behavior involves a mix of parallel execution, shared resource contention, and the potential for blocking due to I/O operations. Threads within the same process can continue executing independently if they are not directly impacted by shared resource contention or locking. However, if resource contention arises, it can cause threads to wait for locks, even if they are not performing blocking I/O operations.

i still think go and java have only difference that in go there are no native threads.. there are gorutines which are more efficient and light weight then OS native threads(in case of java) and there is go scheduler which manages all of this.

however in java OS scheduler manages all this.. and golang behaviour is Non I/o blocking due to this seperate scheduler

You're absolutely correct in your understanding. Your summary accurately captures the key differences between Go and Java when it comes to concurrency and blocking behavior.

To reiterate and clarify:

1. **Concurrency Model**:
    - In GoLang, the concurrency model is based on goroutines and a scheduler managed by the Go runtime. Goroutines are lightweight, and the scheduler efficiently multiplexes a small number of OS threads to manage many goroutines. This architecture allows for high parallelism and efficient management of blocking and non-blocking operations.
    - In Java, the concurrency model is based on traditional OS threads. Each thread maps to an OS thread (native thread). While this provides concurrency, the overhead of creating and managing OS threads can be higher compared to Go's goroutines.
2. **Blocking Behavior**:
    - GoLang's goroutines can be efficiently suspended when they perform blocking operations, allowing other goroutines to continue running. This behavior is managed by the Go runtime's scheduler, which ensures that blocked goroutines don't hinder the overall concurrency of the application.
    - In Java, when a thread performs a blocking I/O operation, it is indeed blocked at the OS thread level. While other threads can continue running if not directly affected by shared resource contention, the overall thread management and blocking behavior rely more on the OS scheduler.
3. **Scheduler Efficiency**:
    - Go's scheduler is designed to handle many goroutines with low overhead, which makes it particularly efficient for concurrency and parallelism.
    - Java's thread-per-request model can lead to higher resource overhead due to the creation and management of native threads, especially when dealing with a large number of concurrent requests.

Your understanding that GoLang's lightweight goroutines and dedicated scheduler contribute to its efficient non-blocking behavior is correct. GoLang's architecture is optimized for concurrency and parallelism, making it well-suited for I/O-intensive and CPU-intensive applications. Java, on the other hand, offers concurrency through traditional OS threads and may require more careful management to achieve similar levels of efficiency and responsiveness.
