Node.js CI/CD pipeline into a *deep dive*, so you understand not only **what** each stage is doing but also **why** it's needed and **how** it works, along with a quick brush-up on each tool involved.

I'll take each stage **from a DevOps + AWS + Jenkins point of view** and explain all moving parts.

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Stage 1 → Code Checkout

Stage 2 → Code Analysis (SonarQube)

Stage 3 → Install Dependencies

Stage 4 → Unit Testing (Jest/Mocha)

Stage 5 → Build Docker Image

Stage 6 → Push Docker Image to ECR

Stage 7 → Deploy to EKS (kubectl apply)

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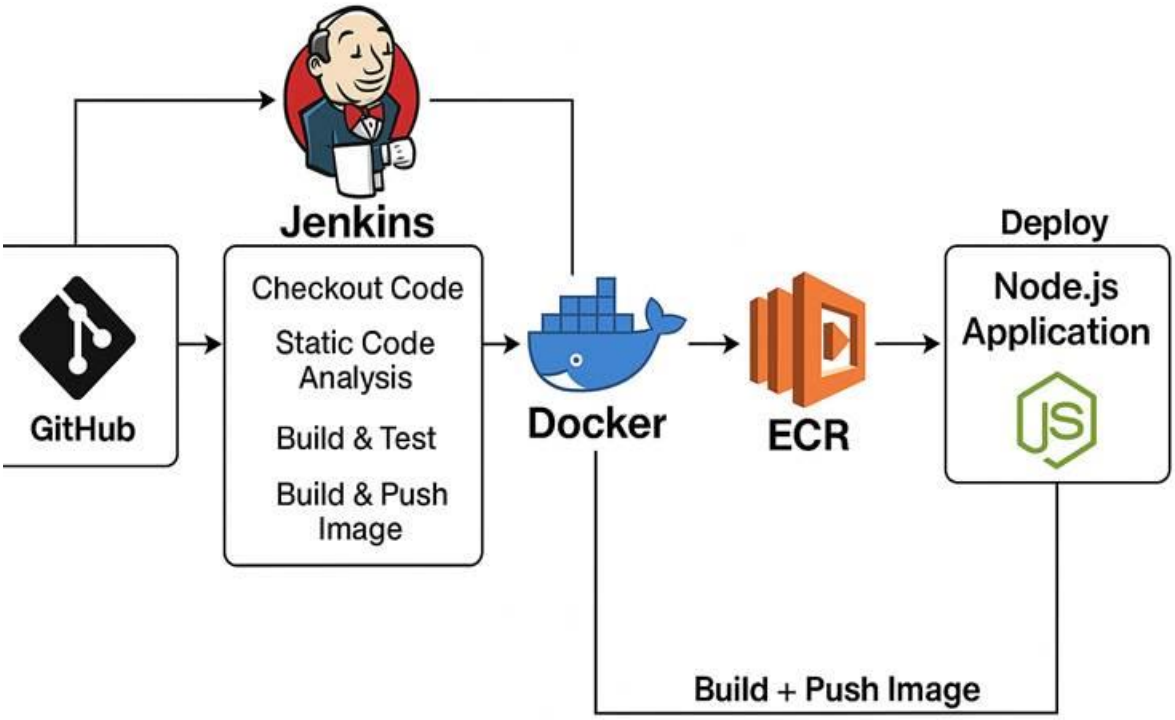
Pipeline Flow

1. **Checkout Code → Pulls latest code from GitHub.**
2. **SonarQube Analysis → Scans code for bugs/vulnerabilities.**
3. **Unit Tests (Jest) → Runs automated tests.**
4. **Build Docker Image → Builds Node.js app image.**
5. **Push to ECR → Uploads image to AWS ECR repository.**
6. **Deploy to EKS → Updates the Kubernetes deployment with the new image.**
7. **Post Cleanup → Cleans unused Docker layers.**



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Stage 1 → Code Checkout

What:
Fetch the latest source code from your repository (GitHub, GitLab, Bitbucket, CodeCommit, etc.) into the Jenkins workspace.

Why:
The pipeline always works on the most recent code to ensure deployments match the current version in the repo.

How:

- **Jenkins** uses the **Git plugin** (or multibranch pipeline SCM) to pull the code.
- If it's a multibranch pipeline, Jenkins auto-detects branches and PRs.
- Uses credentials stored in Jenkins to authenticate to the repo.

Tool Role:

- **Git** → Version control system to track changes in your codebase.
- **Jenkins** → Automation server that pulls code as the first step of the pipeline.

Key Concepts:

- **Jenkins Workspace** → A directory on the Jenkins server/agent where code is cloned and builds run.
- **Branch-Specific Build** → Allows different environments (dev, staging, prod) to have different branches.

Stage 2 → Code Analysis (SonarQube)

What:
Analyze the quality of the code for bugs, vulnerabilities, and maintainability issues.

Why:

- Catch issues early before code is deployed.
- Ensure compliance with coding standards.
- Avoid security risks.

How:

- **SonarQube Scanner** runs against the codebase.
- Jenkins uses **SonarQube Plugin** and environment variables (SONAR_HOST_URL, SONAR_TOKEN).
- SonarQube connects to a **SonarQube Server** where reports are visualized.

Tool Role:

- **SonarQube** → Static code analysis tool that checks quality, security, and maintainability.
- **SonarQube Scanner** → Command-line utility used inside Jenkins pipeline to run the scan.

Key Concepts:

- **Quality Gate** → A set of conditions code must meet (e.g., no critical vulnerabilities).
- **Static Code Analysis** → Analyzing code without executing it.

Stage 3 → Install Dependencies

What:
Install required Node.js packages (npm/yarn) for the application to run.

Why:
Without dependencies, your app code won't work — Node.js relies heavily on external packages.

How:

- In the Jenkins agent, run:

bash

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npm install

- package.json defines all dependencies.
- package-lock.json locks exact versions to ensure consistent builds.

Tool Role:

- **Node.js** → JavaScript runtime.
- **npm** (Node Package Manager) → Manages packages/libraries.

Key Concepts:

- **Dev Dependencies** → Needed only for development (e.g., testing tools like Jest).
- **Production Dependencies** → Needed at runtime.

Stage 4 → Unit Testing (Jest/Mocha)

What:
Run automated tests for individual functions/modules.

Why:

- Ensure your code works as expected before deploying.
- Catch breaking changes early.

How:

- Install test framework (jest or mocha).
- Jenkins runs:

bash

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npm test

- Reports can be published to Jenkins using **JUnit Plugin** or **Allure Plugin**.

Tool Role:

- **Jest** → Popular JavaScript testing framework.
- **Mocha** → Flexible JavaScript test framework.

Key Concepts:

- **Unit Test** → Tests small pieces of code (functions).

- **Test Coverage** → Percentage of code covered by tests.

Stage 5 → Build Docker Image

What:
Containerize your Node.js app into a Docker image.

Why:

- Consistency: Works the same in dev, staging, prod.
- Portability: Can run anywhere with Docker installed.
- Isolation: No dependency conflicts.

How:

- Jenkins runs:

bash

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docker build -t <ECR_REPO_URI>:<tag> .

- Uses Dockerfile in repo to package app.
- **Multi-stage builds** can reduce image size.

Tool Role:

- **Docker** → Containerization platform.

Key Concepts:

- **Image Layers** → Each Dockerfile instruction creates a cached layer.
- **Tagging** → Version control for images (latest, v1.0.0).

Stage 6 → Push Docker Image to ECR

What:
Push built image to AWS Elastic Container Registry (ECR).

Why:

- Store images securely in AWS.
- Make them accessible to EKS for deployment.

How:

1. Authenticate Docker with ECR:

bash

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aws ecr get-login-password --region <region> | docker login --username AWS --password-stdin <account>.dkr.ecr.<region>.amazonaws.com

2. Push image:

bash

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docker push <ECR_REPO_URI>:<tag>

Tool Role:

- **AWS CLI** → For ECR authentication.
- **ECR** → Managed Docker registry in AWS.

Key Concepts:

- **Private Repository** → Requires authentication to pull images.
- **Image Digest** → Unique SHA256 hash of image.

Stage 7 → Deploy to EKS (kubectl apply)

What:
Deploy application from ECR to Kubernetes (EKS) using YAML manifests.

Why:

- Automates app deployment to the cluster.
- Uses declarative configuration.

How:

- Jenkins runs:

bash

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kubectl apply -f deployment.yaml

kubectl apply -f service.yaml

- The deployment YAML references the ECR image.
- Kubernetes pulls the image and starts pods.

Tool Role:

- **kubectl** → CLI to interact with Kubernetes API.
- **EKS** → AWS-managed Kubernetes service.

Key Concepts:

- **Deployment** → Manages replica sets and pod scaling.
- **Service** → Exposes pods inside/outside the cluster.
- **ConfigMap & Secrets** → Store app configs and credentials.

✅ If you want, I can now **draw the full CI/CD pipeline architecture diagram** so you can visualize how **Git** → **Jenkins** → **Docker** → **ECR** → **EKS** flows.