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Beyond the Basics
Advanced Docker for Complex Applications

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Multi-Stage Builds

Multi-stage builds let you split the Dockerfile into stages, producing leaner, optimized images by separating build and runtime environments.

Real-world Scenario:

For large **Node.js apps**, multi-stage builds exclude dev dependencies in production, reducing image size and boosting deployment speed.

Tip:

"Use multi-stage builds to eliminate bloat and streamline deployments."

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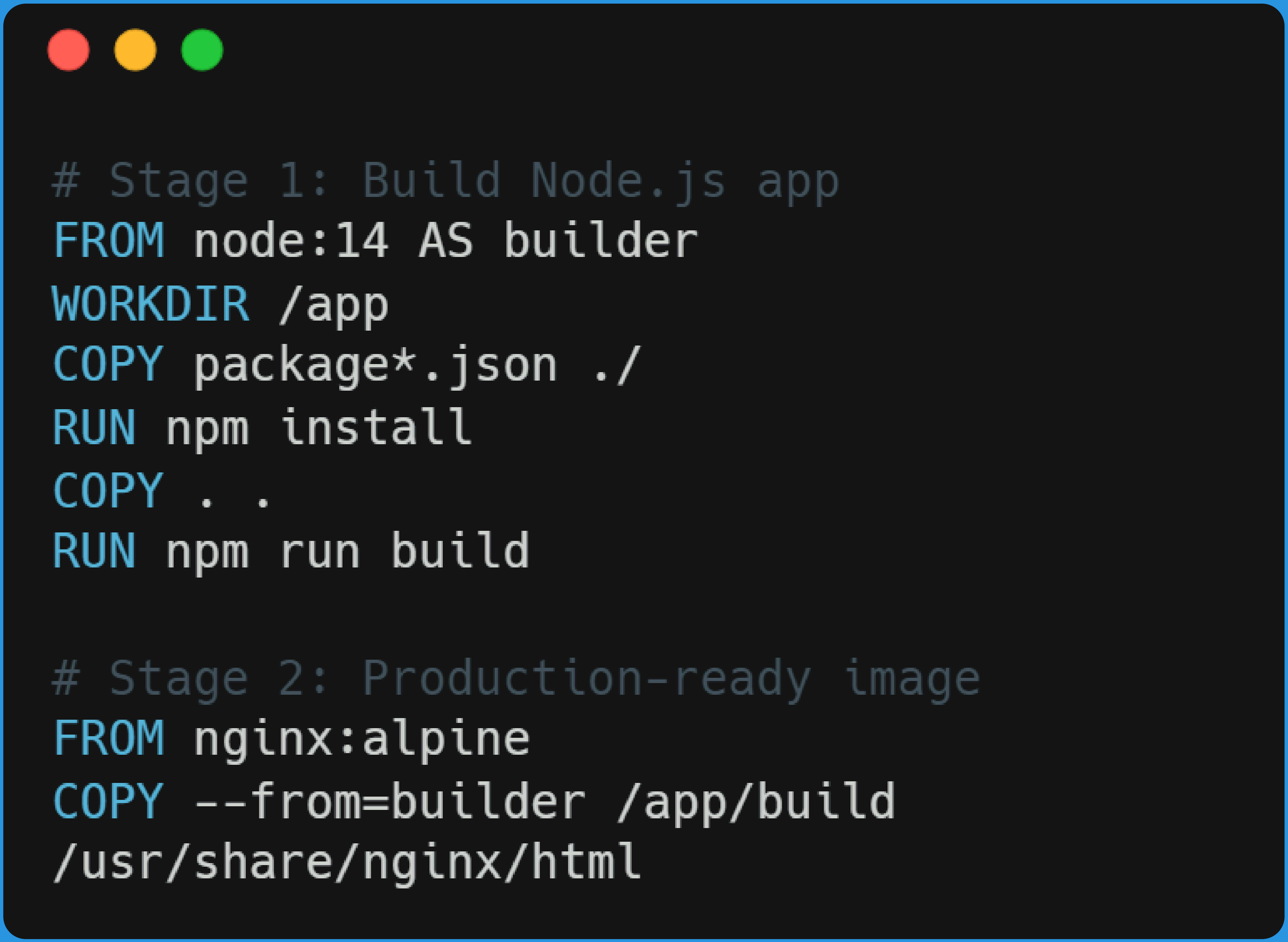
Basic Multi-Stage Dockerfile:



```
# Stage 1: Build Node.js app
FROM node:14 AS builder
WORKDIR /app
COPY package*.json ./
RUN npm install
COPY . .
RUN npm run build

# Stage 2: Production-ready image
FROM nginx:alpine
COPY --from=builder /app/build
/usr/share/nginx/html
```

Key Insight:
Separate build and runtime environments to keep your final image small and efficient.

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Docker Health Checks

Health checks monitor container responsiveness, ensuring the application is functioning properly after startup.

```
HEALTHCHECK --interval=30s --timeout=10s --retries=3 CMD
curl -f http://localhost:8080/health || exit 1
```

Benefit:
Automatic recovery actions when the app becomes unresponsive.

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Docker Volumes for Data Persistence

Docker volumes enable data persistence across container restarts, crucial for databases, logs, and critical data storage.

```
# Create a volume
docker volume create my-volume

# Run container with volume attached
docker run -v my-volume:/app/data my-container
```

Benefit:
Persistent, reliable data storage independent of container lifecycles.

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Docker Swarm and Services

Docker Swarm simplifies orchestration across a cluster of Docker nodes, offering built-in load balancing and scaling.

```
# Initialize Docker Swarm
docker swarm init

# Deploy a service across the swarm
docker service create --name webserver -p 80:80
nginx
```

Benefit:

Easier cluster management with automated failover and scaling.

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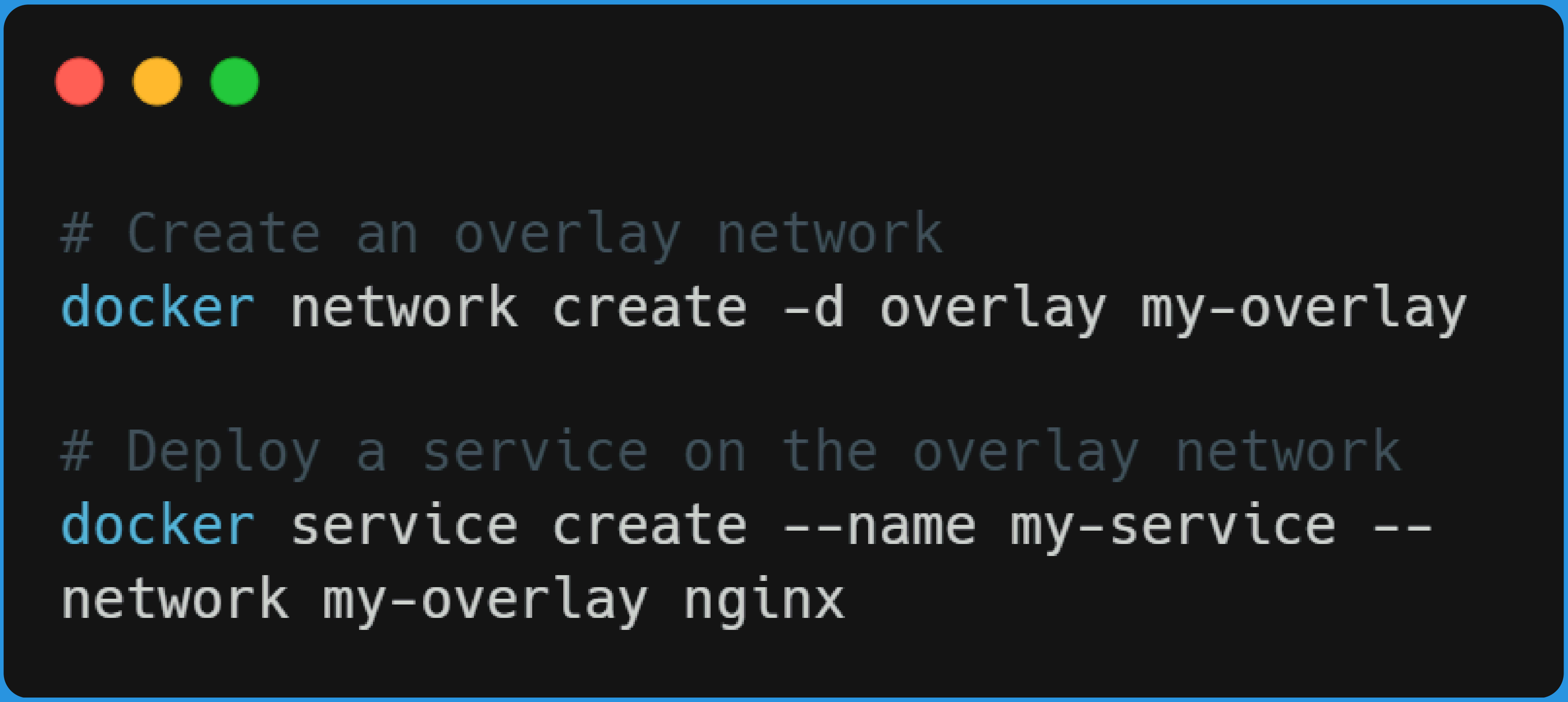
Docker Networking: Overlay Networks

Overlay networks connect containers across multiple hosts, critical for distributed systems in Docker Swarm or Kubernetes.



```
# Create an overlay network
docker network create -d overlay my-overlay

# Deploy a service on the overlay network
docker service create --name my-service --
network my-overlay nginx
```

Benefit:
Secure communication between containers across different nodes.

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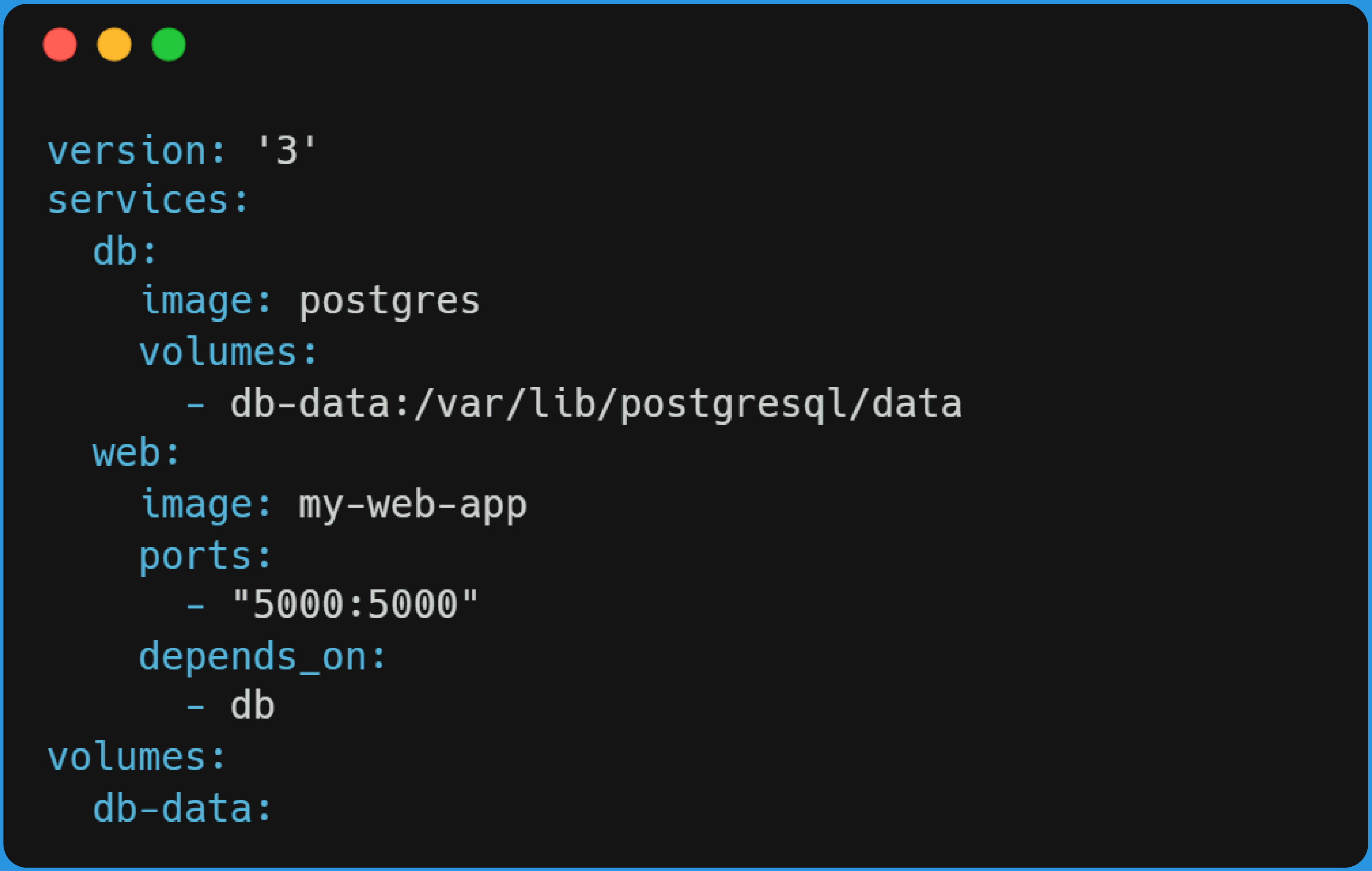
Docker Compose for Multi-Container Applications

Compose simplifies multi-container apps with a declarative YAML configuration, managing containers, volumes, and networks in one file.



```yaml
version: '3'
services:
  db:
    image: postgres
    volumes:
      - db-data:/var/lib/postgresql/data
  web:
    image: my-web-app
    ports:
      - "5000:5000"
    depends_on:
      - db
volumes:
  db-data:
```

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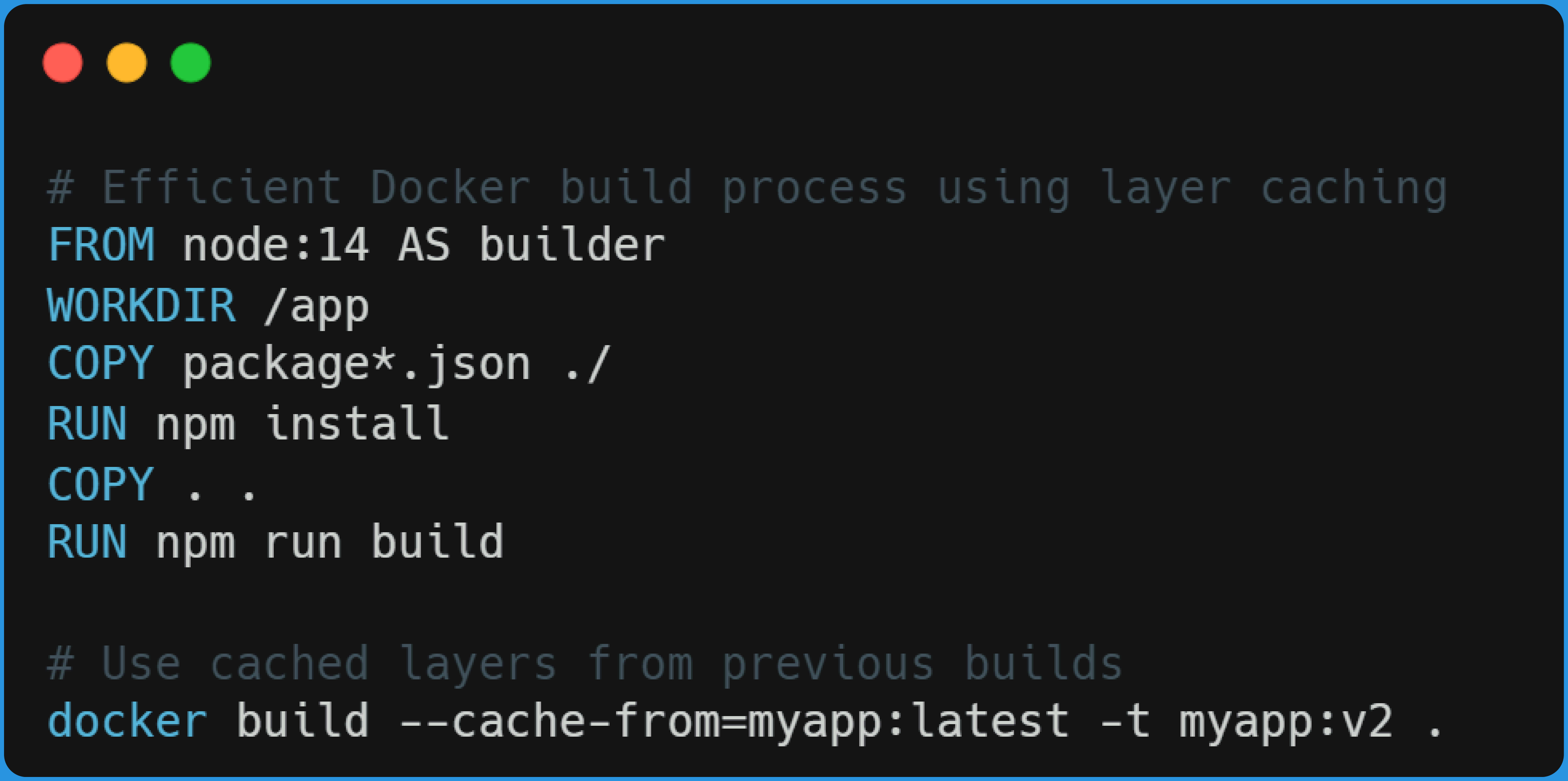
Advanced Caching Strategies in Docker Builds

Here's how to leverage caching to optimize your Docker build process for larger projects. In this example, the **RUN** commands are optimized to reuse layers from previous builds:



```
# Efficient Docker build process using layer caching
FROM node:14 AS builder
WORKDIR /app
COPY package*.json ./
RUN npm install
COPY . .
RUN npm run build

# Use cached layers from previous builds
docker build --cache-from=myapp:latest -t myapp:v2 .
```

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Docker Resource Limits (CPU & Memory)

Control container resource usage by setting CPU and memory limits to prevent any one container from monopolizing resources.

```
docker run --cpus=".5" --memory="512m" my-container
```

Benefit:
Enforced resource limits for better performance management in production.

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Docker Secrets for Managing Sensitive Data

Docker secrets provide secure management of sensitive information (passwords, API keys) in a Swarm, encrypted and accessible only to specific services.

```
echo "my_secret_password" | docker secret create db_password -
docker service create --name my-service --secret db_password my-
image
```

Benefit:
Secure handling of sensitive data in production environments.

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What's your biggest challenge with Docker in complex deployments?

Share your tips or experiences below!