Toolsday Presentation by Konstantin Gredeskoul

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Terraform is Better as a TerraGrunt Sandwich

What We'll Cover Today

- **Infrastructure as Code**: Terraform fundamentals
- **The Problem**: Challenges with pure Terraform projects
- **The Solution**: Enter Terragrunt
- **Practical Example**: Real-world refactoring
- **When to Use**: Benefits vs. overkill scenarios

Infrastructure as Code: A Brief History

Configuration Management vs. Infrastructure Provisioning

2010s

Configuration Management

- Chef, Puppet, Ansible
- Manage software on existing servers
- **Mutable infrastructure**
- Centralized approach
- Potential config drift over time

2018+

Infrastructure Provisioning

- Terraform, CloudFormation
- Create cloud resources
- **Immutable infrastructure**
- Declarative approach
- Version-controlled state

Terraform: The Good Parts

Declarative Language (HCL)

```
resource "aws_instance" "web" {
  ami           = "ami-0c55b159cbfafe1f0"
  instance_type = "t2.micro"

  tags = {
    Name = "WebServer"
  }
}
```

- Multi-cloud support via providers
- Resource dependency management
- State tracking
- Modular architecture

The Terraform Challenges

Problem #1: No Standard Repository Structure

Everyone organizes differently:

```
project-a/              project-b/              project-c/
├── main.tf             ├── infrastructure/     ├── modules/
├── variables.tf        ├── modules/            ├── environments/
└── outputs.tf          └── environments/       └── terraform/
```

No conventions = confusion and inconsistency

The Terraform Challenges

Problem #2: State File Isolation

Each directory maintains its own state:

```
app-infra/
├── main.tf
└── terraform.tfstate    # State A

database/
├── main.tf
└── terraform.tfstate    # State B
```

Requires manual dependency ordering:

1. Deploy database first
2. Get outputs manually
3. Deploy app infrastructure
4. Hope nothing breaks

The Terraform Challenges

Problem #3: Code Duplication (Not DRY)

Need the same infrastructure in dev, staging, and production?

```
environments/
├── dev/
│   ├── main.tf          # Copy-paste
│   ├── variables.tf     # Copy-paste
│   └── backend.tf       # Copy-paste
├── staging/
│   ├── main.tf          # Copy-paste
│   ├── variables.tf     # Copy-paste
│   └── backend.tf       # Copy-paste
└── production/
    ├── main.tf          # Copy-paste
    ├── variables.tf     # Copy-paste
    └── backend.tf       # Copy-paste
```

The Terraform Challenges

Problem #4: Backend Configuration Duplication

Every module needs backend configuration:

```
terraform {
  backend "s3" {
    bucket         = "my-terraform-state"
    key            = "app/terraform.tfstate"
    region         = "us-east-1"
    encrypt        = true
    dynamodb_table = "terraform-locks"
  }
}
```

Repeated in **every single directory** with slight variations

The Terraform Challenges

Problem #5: Circular Dependencies

```
Module A needs output from Module B
Module B needs output from Module C
Module C needs output from Module A ❌
```

Terraform can't handle this automatically

No built-in dependency resolution between separate state files

Enter Terragrunt 

A Thin Wrapper Around Terraform

Terragrunt adds:

- **DRY principles** for backend configuration
- **Dependency management** between modules
- **Automatic state management**
- **Standard repository structure**
- **Remote state handling**
- **Before/after hooks**

Terragrunt Core Concepts

The Unit

A **unit** is the smallest deployable entity:

- One directory with `terragrunt.hcl`
- References a Terraform module
- Has its own inputs and dependencies
- Atomic and hermetic

The Stack

A **stack** is a collection of units:

- Typically represents an environment
- Can be deployed together with `run-all`
- Managed via dependency graph (DAG)

Terragrunt: DRY Backend Configuration

Root `terragrunt.hcl`

```
remote_state {
  backend = "s3"
  config = {
    bucket         = "my-terraform-state"
    key            = "${path_relative_to_include()}/terraform.tfstate"
    region         = "us-east-1"
    encrypt        = true
    dynamodb_table = "terraform-locks"
  }
}
```

Child unit inherits this automatically

```
include "root" {
  path = find_in_parent_folders()
}
```

Terragrunt: Dependency Management

```
dependency "database" {
  config_path = "../database"
}

dependency "vpc" {
  config_path = "../vpc"
}

inputs = {
  db_endpoint = dependency.database.outputs.endpoint
  vpc_id      = dependency.vpc.outputs.vpc_id
}
```

Terragrunt handles the execution order automatically!

Standard Repository Structure

The Terragrunt Way

```
.
├── modules/                    # Reusable Terraform modules
│   ├── app/
│   ├── database/
│   └── vpc/
└── live/                       # Environment-specific configurations
    ├── terragrunt.hcl         # Root configuration
    ├── prod/
    │   ├── us-east-1/
    │   │   ├── app/
    │   │   │   └── terragrunt.hcl
    │   │   └── database/
    │   │       └── terragrunt.hcl
    └── dev/
        └── us-west-2/
            ├── app/
```

Practical Example: Before Terragrunt

Scenario

Deploy a Python web application with PostgreSQL database across:

- Development (us-west-2)
- Staging (us-east-1)
- Production (us-east-1)

Pure Terraform Structure

```
terraform-project/
├── modules/
│   ├── web-app/
│   │   ├── main.tf
│   │   ├── variables.tf
│   │   └── outputs.tf
│   └── postgresql/
│       ├── main.tf
│       ├── variables.tf
│       └── outputs.tf
└── environments/
    ├── dev/
    │   ├── main.tf
    │   ├── variables.tf
    │   ├── backend.tf           # Duplicated
    │   └── terraform.tfvars
```

Pure Terraform: The Module

modules/web-app/main.tf

```
variable "app_name" {}
variable "docker_image" {}
variable "db_endpoint" {}
variable "environment" {}

resource "aws_ecs_cluster" "app" {
  name = "${var.app_name}-${var.environment}"
}

resource "aws_ecs_service" "app" {
  name            = "${var.app_name}-service"
  cluster         = aws_ecs_cluster.app.id
  task_definition = aws_ecs_task_definition.app.arn
  desired_count   = 1

  load_balancer {
```

Pure Terraform: Environment Config

environments/prod/main.tf

```
terraform {
  backend "s3" {
    bucket = "mycompany-terraform-state"
    key    = "prod/terraform.tfstate"
    region = "us-east-1"
  }
}

module "database" {
  source = "../../modules/postgresql"

  db_name     = "myapp"
  environment = "prod"
  region      = "us-east-1"
}
```

Same code repeated for dev and staging with tiny differences!

Pure Terraform: The Pain Points

Deployment Process

```
# For each environment:
cd environments/prod

# Deploy database first
terraform init
terraform plan -target=module.database
terraform apply -target=module.database

# Wait... get outputs manually

# Then deploy app
terraform plan -target=module.web_app
terraform apply -target=module.web_app
```

Manual dependency management 😩 Lots of copy-paste code 😩 No DRY backend config 😩

After Terragrunt: Repository Structure

```
terragrunt-project/
├── modules/                          # Terraform modules (unchanged)
│   ├── web-app/
│   │   ├── main.tf
│   │   ├── variables.tf
│   │   └── outputs.tf
│   └── postgresql/
│       ├── main.tf
│       ├── variables.tf
│       └── outputs.tf
└── live/                             # Terragrunt configurations
    ├── terragrunt.hcl                # Root config (DRY!)
    ├── prod/
    │   └── us-east-1/
    │       ├── database/
    │       │   └── terragrunt.hcl  # 20 lines
```

Terragrunt: Root Configuration

live/terragrunt.hcl

```
# DRY backend configuration
remote_state {
  backend = "s3"
  generate = {
    path      = "backend.tf"
    if_exists = "overwrite"
  }
  config = {
    bucket         = "mycompany-terraform-state"
    key            = "${path_relative_to_include()}/terraform.tfstate"
    region         = "us-east-1"
    encrypt        = true
    dynamodb_table = "terraform-locks"
  }
}
```

Terragrunt: Database Unit

live/prod/us-east-1/database/terragrunt.hcl

```
include "root" {
  path = find_in_parent_folders()
}

terraform {
  source = "../../../../modules/postgresql"
}

inputs = {
  db_name     = "myapp"
  environment = "prod"
  region      = "us-east-1"
  instance_class = "db.t3.large"
}
```

That's it! 15 lines vs. 100+ lines of duplicated Terraform

Terragrunt: Web App Unit (With Dependencies)

live/prod/us-east-1/web-app/terragrunt.hcl

```
include "root" {
  path = find_in_parent_folders()
}

terraform {
  source = "../../../../modules/web-app"
}

dependency "database" {
  config_path = "../database"

  mock_outputs = {
    endpoint = "mock-db-endpoint.rds.amazonaws.com"
  }
}
```

Terragrunt: Simplified Deployment

Deploy Everything

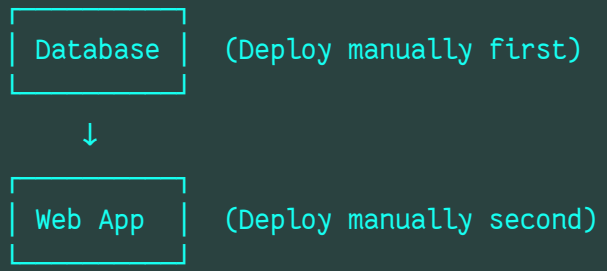
```
cd live/prod/us-east-1
terragrunt run-all apply
```

Terragrunt automatically:

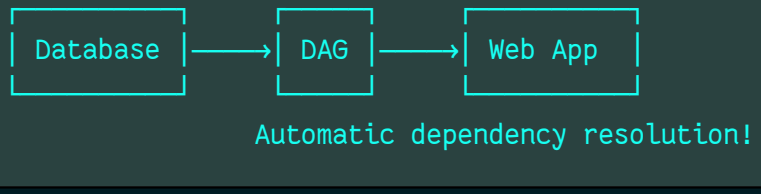
1. Analyzes dependency graph
2. Deploys database first
3. Waits for outputs
4. Deploys web-app with database endpoint
5. Handles errors and retries

Terragrunt: Dependency Visualization

Pure Terraform (Manual)



With Terragrunt (Automatic)



Code Comparison: Lines of Code

Pure Terraform Approach

```
Backend configs:     3 × 15 lines  =  45 lines
Main configs:        3 × 50 lines  = 150 lines
Variables:           3 × 30 lines  =  90 lines
Total:                              285 lines (highly duplicated)
```

Terragrunt Approach

```
Root config:                        30 lines
Database units:      3 × 15 lines  = 45 lines
Web app units:       3 × 25 lines  = 75 lines
Total:                             150 lines (DRY, no duplication)
```

~47% reduction in code! 🎉

When Terragrunt Shines ⭐

Maximum Benefits When You Have

1. **Multiple environments** (dev, staging, prod)
2. **Complex dependencies** between infrastructure components
3. **Multiple regions** or cloud accounts
4. **Large teams** needing consistent structure
5. **Frequent infrastructure changes** requiring maintainability
6. **Shared modules** across many projects

When Terragrunt Might Be Overkill 🤔

Consider Plain Terraform If

1. **Single environment** deployment
2. **Simple, flat infrastructure** (no dependencies)
3. **Small project** with <5 resources
4. **One-time deployment** with no updates
5. **Solo developer** with no collaboration needs
6. **Proof of concept** or learning Terraform basics

Start simple, add Terragrunt when complexity grows

Key Benefits Summary

1. **DRY Principle**: Write backend configuration once, inherit everywhere
2. **Dependency Management**: Automatic execution order based on dependency graph
3. **Standard Structure**: Clear conventions for organizing infrastructure code
4. **Reduced Code Duplication**: ~40-60% less code to maintain
5. **Version Control**: Pin module versions per environment
6. **Mock Outputs**: Test and plan without deploying dependencies
7. **Bulk Operations**: Deploy/destroy entire stacks with run-all
8. **Hooks**: Execute custom commands before/after Terraform

Common Issues Terragrunt Solves

Without Terragrunt ❌

- Copy-paste backend configs
- Manual dependency ordering
- Inconsistent repo structures
- Hard to scale across teams
- Circular dependency deadlocks
- Error-prone deployments
- State file confusion

With Terragrunt ✅

- Backend config inheritance
- Automatic dependency DAG
- Standard folder structure
- Team-friendly conventions
- Dependency cycle detection
- Orchestrated deployments
- Clear state organization

Terragrunt Advanced Features

Auto-init

Automatically runs `terraform init`

Mock Outputs

Test without deploying dependencies:

```
dependency "vpc" {
  config_path = "../vpc"
  mock_outputs = {
    vpc_id = "vpc-mock123"
  }
}
```

Before/After Hooks

```
terraform {
  before_hook "validate" {
    commands = ["apply", "plan"]
    execute  = ["terraform", "fmt", "-check"]
  }
}
```

Migration Strategy

Incremental Adoption Path

1. **Start small**: Add root `terragrunt.hcl` with backend config
2. **Refactor modules**: Extract reusable Terraform modules
3. **Create units**: Convert environments to Terragrunt units
4. **Add dependencies**: Define relationships between units
5. **Test thoroughly**: Validate with `plan` before `apply`
6. **Train team**: Share knowledge and best practices

No need to migrate everything at once!

Terragrunt + Terraform = ❤️

Best Practices

- **Keep modules pure**: Terraform modules should be Terragrunt-agnostic
- **Use mock outputs**: Enable testing without dependencies
- **Version everything**: Pin module versions explicitly
- **Automate CI/CD**: Use `terragrunt run-all plan` in pipelines
- **Document dependencies**: Make DAG clear for team members
- **Start with conventions**: Use standard folder structure from day one

Resources & Documentation

Official Documentation

- Terragrunt: terragrunt.gruntwork.io
- Terraform: terraform.io

Recommended Reading

- Terragrunt: How to Keep Your Code DRY
- Terragrunt vs Terraform
- Understanding Terraform

The Bottom Line

Terraform is great for infrastructure provisioning

Terragrunt makes it **maintainable**, **scalable**, and **team-friendly**

Terraform is better as a TerraGrunt sandwich! 🥪

Thanks

Any Questions?
Comments?
Feedback?

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