Date: 15.07.2025

Ansible

Contents

1. Introduction

a. What is Ansible?

Ansible is an open-source automation tool primarily used for **configuration management**, **application deployment**, **task automation**, and **orchestration**. It helps automate repetitive IT tasks, making system administration easier, more consistent, and scalable.

Ansible uses a simple, human-readable language based on YAML (Yet Another Markup Language) called **playbooks** to describe automation jobs.

b. Key Features

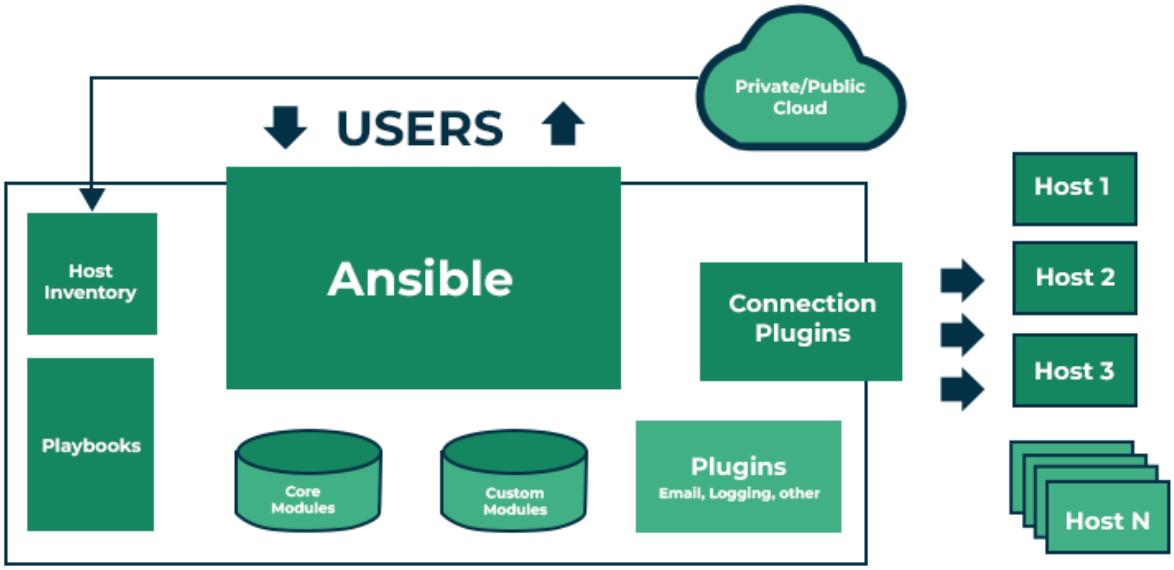
Feature	Description
Agentless Architecture	Does not require any agent software on target machines; communicates over SSH (Linux/Unix) or WinRM (Windows).
Simple and Easy to Learn	Playbooks are written in YAML, which is straightforward and readable, even for non-programmers.
Idempotency	Tasks are idempotent, so they can run multiple times without causing unintended changes.
Extensible with Modules	Includes a large library of built-in modules and supports custom modules for managing systems and apps.
Agentless and Secure	Uses SSH keys for secure communication, eliminating the need for extra software on managed nodes.
Powerful Orchestration	Supports complex workflows with dependencies and conditional execution across multiple systems.
Wide Platform Support	Compatible with Linux, Unix, Windows, network devices, cloud platforms, containers, and more.

c. Ansible vs Its Alternatives

Feature	Ansible	Puppet	Chef	SaltStack
Agent Required?	No	Yes	Yes	Optional
Language	YAML (Playbooks)	Domain-Specific Language	Ruby DSL	YAML / Python
Learning Curve	Low	Moderate	Moderate to High	Moderate
Orchestration	Strong	Moderate	Moderate	Strong
Configuration	Push-based	Pull-based	Pull-based	Both
Extensibility	Extensive modules, plugins	Modules and manifests	Cookbooks	Modules and states

2. Core Concepts

Concept	Description	Notes
Control Node	The machine where Ansible is installed and run	Your laptop or server controlling other machines
Managed Nodes	Remote machines Ansible manages	Servers, cloud instances, network devices
Inventory	List of managed nodes (hosts)	Static file or dynamic script listing servers
Modules	Pre-built tools to perform tasks on managed nodes	apt for package install, service for services
Playbooks	YAML files describing automation workflows	Define tasks to run on hosts
Roles	Reusable, organized collections of tasks and files	Standard directory structure for easier sharing
Variables	Values that customize tasks and playbooks	OS type, usernames, paths
Facts	Automatically collected system info from managed nodes	IP address, OS version
Handlers	Tasks triggered by other tasks (usually for restarts)	Restart service after config changes
Templates	Jinja2 files used to create dynamic configuration files	Config files with variables inside



3. Installing and Setting up Ansible

a. Installation

Refer this for Ansible Installation: [Installation Guide — Ansible Documentation]

b. Setting up SSH Access from control node to managed nodes

1. Generate SSH key on control node - `ssh-keygen`
2. Copy public key to managed nodes - `ssh-copy-id user@<managed-node-ip>`

c. Configuring Inventory file

The inventory file lists hosts managed by Ansible.
Default location: `/etc/ansible/hosts`
You can group hosts and refer to groups in playbooks.

```
[webservers]
web1.example.com
web2.example.com
[dbservers]
db1.example.com
```

d. ansible.cfg Configuration File

Controls Ansible settings such as:

- Default inventory location
- Remote user
- SSH options
- Privilege escalation settings (sudo)

```
[defaults]
inventory = ./hosts
remote_user = ubuntu
private_key_file = ~/.ssh/id_rsa
```

Place `ansible.cfg` in your project directory or home directory.

4. Basic Usage

a. Running Ad-Hoc Commands

Ad-hoc commands let you execute simple tasks directly from the command line without writing a playbook.
Syntax: `ansible <host-pattern> -m <module> -a "<module-arguments>"`
Examples:

- Ping all hosts in inventory: `ansible all -m ping`
- Check uptime on webservers: `ansible webservers -m command -a "uptime"`
- Install a package using apt: `ansible all -m apt -a "name=htop state=present" --become`

b. Running Playbooks

A playbook is a YAML file containing tasks to run on specified hosts.

install_apache.yml	**Run it**

- name: Install Apache web server
  hosts: webservers
  become: true
  tasks:
  - name: Ensure Apache is installed
  apt:
  name: apache2
  state: present
  - name: Ensure Apache is running
  service:
  name: apache2
  state: started
  enabled: true
	`ansible-playbook install_apache.yml`

c. Using Variables

Variables let you customize your playbooks without hardcoding value

```
- name: Install a package with a variable
  hosts: all
  vars:
    package_name: htop

  tasks:
    - name: Install package
      apt:
        name: "{{ package_name }}"
        state: present
```

d. Conditionals and Loops

Conditionals	Loops

- name: Install Nginx only on Debian
  apt:
  name: nginx
  state: present
  when: ansible_facts['os_family'] == "Debian"
	- name: Install multiple packages
	  apt:
	  name: "{{ item }}"
	  state: present
	  loop:
	  - git
	  - curl
	  - htop

e. Tags and Includes

- **Tags** allow you to run specific parts of a playbook
- **Includes** break playbooks into smaller files

Tags	Includes

- name: Install and configure
  hosts: all
  tasks:
  - name: Install nginx
  apt:
  name: nginx
  state: present
  tags: install
 	
  - name: Configure nginx
  template:
  src: nginx.conf.j2
  dest: /etc/nginx/nginx.conf
  tags: config
	- name: Load common tasks
	  import_tasks: common.yml

Run only the install task: `ansible-playbook site.yml --tags install`

5. Playbook Structure and Syntax

a. Basic Playbook Structure

General Description	Example

- name: Description of the play
  hosts: group_or_host
  become: true # for privilege escalation
  vars:
  some_var: value
 	
  tasks:
  - name: Description of task 1
  module_name:
  option1: value1
  option2: value2
 	
  - name: Description of task 2
  module_name:
  ...
	- name: Install and start Apache
	  hosts: webservers
	  become: true
	
	  tasks:
	  - name: Install Apache
	  apt:
	  name: apache2
	  state: present
	  update_cache: yes
	
	  - name: Start Apache
	  service:
	  name: apache2
	  state: started
	  enabled: true

b. Common Modules and Syntax

Module	Purpose	Example
apt, yum	Package management	name=nginx state=present
service	Manage services	name=nginx state=started enabled=true
copy	Copy files to remote hosts	src=local.conf dest=/etc/config.conf
template	Use Jinja2 templates	src=file.j2 dest=/etc/file.conf
command	Run raw shell commands	command: uptime
file	Set file attributes	path=/etc/file mode=0644 state=touch
user	Manage users	name=john state=present shell=/bin/bash

c. Other Concepts

Error Handling and Retries	Debugging

- name: Try a command with retries
  command: /path/to/sometimes_fails.sh
  register: result
  retries: 3
  delay: 5
  until: result.rc == 0
	- name: Show variable value
	  debug:
	  var: ansible_facts['distribution']
	Or for custom messages:
	- debug:
	  msg: "This is a debug message"

d. Best Practices

- **Use descriptive names**: Makes tasks easier to understand.
- **Group related tasks**: Keeps your work organized and readable.
- **Use variables**: Avoids hardcoding and makes reuse easier.
- **Separate logic into roles**: Helps make playbooks modular and reusable.
- **Use version control**: Lets you track and manage changes with tools like Git.

6. Roles and Reusability

a. What Is a Role?

A **role** is a structured directory layout that contains everything needed to automate a specific task or feature, such as installing a web server or setting up a database.
Each role can contain:

- Tasks
- Handlers
- Variables
- Templates
- Files
- Defaults
- Metadata

b. Role Directory Structure

Only tasks/main.yml is **required**; the rest are optional.

```
my_role/
 |-- defaults/
      |-- main.yml          # Default variables
 |-- files/
      |-- example.conf       # Static files to copy
 |-- handlers/
      |-- main.yml          # Handlers triggered by tasks
 |-- meta/
      |-- main.yml          # Role metadata (dependencies, etc.)
 |-- tasks/
      |-- main.yml          # Main list of tasks
 |-- templates/
      |-- config.j2         # Jinja2 templates
 |-- vars/
      |-- main.yml          # Variables with higher priority
```

c. Creating a Role

To create a role: `ansible-galaxy init my_role`
This automatically generates the folder structure above.

d. Using Roles in a Playbook

Basic Role Usage	Role with Variables
- name: Apply webserver role hosts: webservers become: true roles: - webserver	roles: - role: nginx vars: listen_port: 8080

e. Sharing and Downloading Roles (Ansible Galaxy)

Ansible Galaxy is a hub where you can find and share roles.

Installing a role	Using installed role
`ansible-galaxy install geerlingguy.nginx`	roles: - geerlingguy.nginx

f. include_role vs roles

- roles (in a play): used in the `roles:` section of a play.
- include_role (in a task): dynamically include a role inside a task.

g. Benefits of Using Roles

- **Reusability**: Use the same role across different playbooks or projects.
- **Organization**: Keeps tasks, variables, and templates well-structured.
- **Modularity**: Makes it easier to develop and test small parts of automation.
- **Shareability**: Roles can be shared through Ansible Galaxy or Git.

7. Advanced Features

a. Ansible Vault

Ansible Vault is used to **encrypt sensitive data** like passwords, keys, or secrets.

Encrypt a file	ansible-vault encrypt secrets.yml
Decrypt a file	ansible-vault decrypt secrets.yml
Edit encrypted file	ansible-vault edit secrets.yml
Run playbook with vault	ansible-playbook playbook.yml --ask-vault-pass

You can also use vault IDs or key files for non-interactive decryption.

b. Templates with Jinja2

Templates let you create dynamic configuration files using **Jinja2** syntax and Ansible variables.

Example template (nginx.conf.j2)	In playbook

server {
listen {{ port }};
server_name {{ domain }};
root {{ web_root }};
}
	- name: Deploy nginx config
	template:
	src: nginx.conf.j2
	dest: /etc/nginx/nginx.conf

c. Dynamic Inventories

Instead of static inventory files, you can use **scripts or cloud plugins** to dynamically generate host lists (e.g., AWS, GCP, Azure).

`ansible-inventory -i aws_ec2.yml --graph`

To use:

- Install cloud collection (e.g., amazon.aws)
- Create inventory plugin config (aws_ec2.yml)
- Reference with -i aws_ec2.yml

d. Callback Plugins

Callback plugins change **how Ansible displays output** or reports status.
Common use: pretty output, JSON logs, sending results to Slack.
More examples:

- json: machine-readable output
- minimal: less noisy output
- slack: send playbook results to Slack (custom plugin)

Enable in ansible.cfg
[defaults] stdout_callback = yaml

e. Custom Modules

You can create your own Ansible modules in Python.

Structure	Use with

#!/usr/bin/python
from ansible.module_utils.basic import AnsibleModule
 	
def main():
module =
AnsibleModule(argument_spec=dict(name=dict(type='str',
required=True)))
name = module.params['name']
module.exit_json(changed=False, msg=f"Hello {name}")
 	
if __name__ == '__main__':
main()
	- name: Run custom module
	my_module:
	name: world

Put your module in library/ or set library = ./library in ansible.cfg.

f. Collections

Collections package multiple roles, plugins, and modules together.

Install from Ansible Galaxy	Use in playbook
`ansible-galaxy collection install community.general`	- name: Use community.general collection community.general.handy_module: option: value

g. Asynchronous Tasks

Run long tasks **in the background**:
You can later check job status with polling.

```
- name: Run a script asynchronously
  command: /usr/bin/long_script.sh
  async: 300
  poll: 0
```

8. Best Practices

a. Directory Structure

```
project/
 |-- ansible.cfg
 |-- inventory/
 |    |-- hosts.yml
 |    |-- group_vars/
 |         |-- all.yml
 |-- playbooks/
 |    |-- webserver.yml
 |    |-- database.yml
 |-- roles/
 |    |-- common/
 |    |-- nginx/
 |-- templates/
```

Use roles/ to modularize tasks, and group your inventories and variables for better organization.

b. Use Roles and Collections

- Break large playbooks into reusable roles.
- Share roles using **Ansible Galaxy** or **collections**.
- Name roles clearly and consistently (e.g., webserver, db_setup).

c. Keep Playbooks Idempotent

- Tasks should be **safe to run multiple times** without causing unintended side effects.
- Use modules like apt, copy, file instead of raw commands to ensure idempotency.

Good	Bad
yaml - name: Install nginx apt: name: nginx state: present	yaml - name: Install nginx (non-idempotent) command: apt install nginx

d. Protect Sensitive Data

- Use **Ansible Vault** for passwords, secrets, API keys.
- Avoid storing plaintext credentials in playbooks or Git.

  `ansible-vault encrypt secrets.yml`

e. Test Changes Locally First

- Use **Vagrant**, **Docker**, or a test environment before applying to production.
- Use --check (dry-run) mode: `ansible-playbook site.yml --check`

f. Use Tags Wisely

Tag tasks to run only specific parts of a playbook

Run only restart tasks:
`ansible-playbook site.yml --tags restart`

```
- name: Restart nginx
  service:
    name: nginx
    state: restarted
  tags: restart
```

g. Track and Log Outputs

- Use verbose mode (-v, -vvv) when debugging: `ansible-playbook site.yml -vv`
- Use callback plugins for structured output (e.g., JSON, YAML).

h. Use Variables and Defaults

- Centralize values in group_vars/ or defaults/main.yml.
- Avoid hardcoding values across multiple playbooks.

i. Reuse and Share Code

- Create **roles**, not repetitive tasks.
- Use **includes**, **import_tasks**, and **handlers** for modularity.
- Share reusable components with your team or publish to Ansible Galaxy.

j. Lint and Validate

- Use **ansible-lint** to catch common errors: `ansible-lint playbook.yml`
- Validate syntax before running: `ansible-playbook playbook.yml --syntax-check`

9. Troubleshooting and Debugging

a. Use Verbose Mode

Command	Description
ansible-playbook site.yml -v	Shows basic info about tasks and results
ansible-playbook site.yml -vv	Adds more output (e.g., variables, changes)
ansible-playbook site.yml -vvv	Shows SSH details, task arguments, and full debug
ansible-playbook site.yml -vvvv	Includes connection debugging and internal data (rarely needed)

b. Use the debug Module

Use the debug module in playbooks to print variables or custom messages

```
- name: Show variable
  debug:
    var: ansible_facts['distribution']
- name: Print custom message
  debug:
    msg: "Web root is set to {{ web_root }}"
```

c. Dry Run with --check

The --check flag runs the playbook in **"dry run"** mode: `ansible-playbook site.yml --check`

- Shows what would change without making any changes.
- Great for testing logic or reviewing pending updates.

d. Validate Syntax Before Running

Catch errors early with: `ansible-playbook playbook.yml --syntax-check`
This checks for YAML formatting and module errors.

e. Register and Inspect Results

Use register to capture output from a task and analyze it in later tasks:

```
- name: Run shell command
  shell: uptime
  register: result
- debug:
    var: result.stdout
```

f. Examine Logs (if using callback plugins)

Enable logging in ansible.cfg:

```
[defaults]
log_path = ./ansible.log
```

This stores detailed logs that can be reviewed after execution.

g. Common Errors and Fixes

Error	Possible Cause	Fix
UNREACHABLE!	SSH error or host is down	Check SSH config, network, hostnames
FAILED! => {"msg": "Module not found"}	Missing or misspelled module	Check spelling or module availability
Permissions denied (sudo error)	Wrong become settings or user rights	Ensure correct become: true and user configs
YAML syntax error	Incorrect spacing or indentation	Validate with --syntax-check, use 2 spaces
Variable undefined	Variable not set or misnamed	Set in vars, defaults, or group_vars

h. Use ansible-lint

Catch common mistakes with this linter tool: `ansible-lint playbook.yml`
It checks for:

- Deprecated module usage
- Bad practices
- Missing handlers or variables
- Improper formatting

i. **Use --start-at-task for Focused Debugging**
Resume a playbook at a specific task by name: `ansible-playbook site.yml --start-at-task="Install packages"`
Helps when debugging failures late in a playbook.

j. **Use --step to Confirm Before Each Task**
This interactive mode asks you before running each task: `ansible-playbook site.yml --step`
Useful when trying to isolate where a problem starts.

10. Real-World Examples

a. **Example 1: Web Server Deployment (Nginx)**
Objective: Install and configure Nginx on a group of webservers.

Directory Structure

```
nginx_deploy/
|-- playbook.yml
|-- templates/
|    |-- nginx.conf.j2
|-- inventory/
    |-- hosts
```

inventory/hosts

```
[webservers]
192.168.1.10
```

templates/nginx.config.j2

```
server {
    listen {{ nginx_port }};
    server_name localhost;

    location / {
        root /var/www/html;
        index index.html;
    }
}
```

playbook.yml

```
- name: Deploy Nginx on web servers
  hosts: webservers
  become: true

  vars:
    nginx_port: 80

  tasks:
    - name: Install Nginx
      apt:
        name: nginx
        state: present
        update_cache: yes

    - name: Configure Nginx
      template:
        src: templates/nginx.conf.j2
        dest: /etc/nginx/nginx.conf

    - name: Start and enable Nginx
      service:
        name: nginx
        state: started
        enabled: true
```

`ansible-playbook nginx_deploy/playbook.yml -i nginx_deploy/inventory/hosts`

b. Example 2: Managing Encrypted Secrets

Objective: Store a database password securely.

Directory Structure	playbook.yml
vault_example/ |-- playbook.yml |-- templates/ | |-- db_config.j2 |-- inventory/ | |-- hosts |-- group_vars/ |-- dbservers/ |-- vault.yml	- name: Configure database hosts: dbservers become: true tasks: - name: Set DB password template: src: templates/db_config.j2 dest: /etc/db.conf
inventory/hosts	
[dbservers] 192.168.1.20	
group_vars/dbservers/vault.yml	templates/db_config.j2
db_password: "SuperSecret123" // `ansible-vault create vault.yml`	DB_PASSWORD={{ db_password }}

`ansible-playbook vault_example/playbook.yml -i vault_example/inventory/hosts --ask-vault-pass`

c. Example 3: Provision AWS EC2 Instances (with amazon.aws collection)

Directory Structure	playbook.yml
aws_ec2/ |-- playbook.yml	- name: Launch EC2 instance hosts: localhost gather_facts: false vars: key_name: my-key region: us-east-1 tasks: - name: Launch EC2 instance amazon.aws.ec2_instance: key_name: "{{ key_name }}" region: "{{ region }}" instance_type: t2.micro image_id: ami-0abcdef1234567890 wait: yes count: 1 register: ec2
Install Collection	
ansible-galaxy collection install amazon.aws	

`ansible-playbook aws_ec2/playbook.yml -i localhost,` [`-i localhost,` → Interpreted as a literal host]

d. Example 4: Use of Roles in a Complete Playbook

Directory Structure

```
project/
|-- playbook.yml
|-- roles/
    |-- apache/
        |-- tasks/
        |   |-- main.yml
        |-- templates/
            |-- httpd.conf.j2
```

playbook.yml

```
- name: Setup Apache
  hosts: webservers
  become: true
  roles:
    - apache
```

roles/apache/templates/httpd.conf.j2

```
ServerName localhost
<Directory /var/www/html>
    Options Indexes FollowSymLinks
    AllowOverride None
    Require all granted
</Directory>
```

roles/apache/tasks/main.yml

```
- name: Install Apache
  apt:
    name: apache2
    state: present

- name: Deploy config
  template:
    src: httpd.conf.j2
    dest: /etc/apache2/apache2.conf

- name: Start Apache
  service:
    name: apache2
    state: started
    enabled: true
```

`ansible-playbook project/playbook.yml -i project/inventory/hosts`

e. Example 5: CI/CD Integration

Directory Structure	.github/workflows/deploy.yml
cicd/ |-- .github/ | |-- workflows/ | |-- deploy.yml |-- deploy.yml |-- inventory/ | |-- hosts	jobs: deploy: runs-on: ubuntu-latest steps: - name: Checkout code uses: actions/checkout@v3 - name: Set up Ansible run: | sudo apt update sudo apt install ansible -y - name: Run Ansible playbook run: | ansible-playbook deploy.yml -i inventory/hosts --key-file ~/.ssh/id_rsa
inventory/hosts	
[webservers] myserver.example.com	
deploy.yml (Example Ansible playbook)	
- name: CI Deployed Webserver hosts: webservers become: true tasks: - name: Ensure Nginx is installed apt: name: nginx state: present	

`ansible-playbook cicd/deploy.yml -i cicd/inventory/hosts --key-file ~/.ssh/id_rsa`
(For local testing)