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Designing Applications for Cloud Foundry

People matter, results count.

Objectives of CF – Design Applications

- Purpose:
  - To learn pivotal cloud foundry 12-Factor Applications
- Product:
  - 12-Factor Applications
  - Design Guidelines
- Process:
  - To learn 12-Factor Applications and design guidelines of Cloud Foundry to develop Cloud Applications.

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12-FACTOR APPLICATIONS

12-Factor Application

- http://12factor.net

- Outlines architectural principles for modern apps
  - Focus on scaling, continuous delivery, portable and cloud ready

12-Factor Application

I. Codebase One codebase tracked in SCM, many deploy	**II. Dependencies** Explicitly declare and isolate dependencies	**III. Configuration** Store config in the environment
IV. Backing Services Treat backing services as attached resources	**V. Build, Release, Run** Strictly separate build and run stages	**VI. Processes** Execute app as stateless processes
VII. Port binding Export services via port binding	**VII. Concurrency** Scale out via the process model	**IX. Disposability** Maximize robustness with fast startup and graceful shutdown
X. Dev/ prod parity Keep dev, staging, prod as similar as possible	**XI. Logs** Treat logs as event streams	**XII. Admin processes** Run admin/ mgmt tasks as one-off processes

12- Factor Application

I. Codebase	II. Dependencies	III. Configuration
One codebase tracked in SCM, many deploy	Explicitly declare and isolate dependencies	Store config in the environment

- Codebase
  - An application has a single codebase
    - Multiple codebase = distributed system (not an app)
      - Each component in a codebase can (should) be an app
    - Tracked in version control
      - Git, Subversion, Mercurial, etc.
    - Multiple deployments
      - i.e development, testing, staging, production, etc.

12- Factor Application

I. Codebase
One codebase tracked in SCM, many deploy

II. Dependencies
Explicitly declare and isolate dependencies

III. Configuration
Store config in the environment

- Dependencies
  - <u>Packaged</u> as jars (java), RubyGems, CPAN (Perl)
  - <u>Declared</u> in Manifest
    - Maven POM, Gemfile / bundle exec, etc.
  - No reliance on specific system tools
    - i.e Linux tool not available on windows

12- Factor Application

I. Codebase	II. Dependencies	III. Configuration
One codebase tracked in SCM, many deploy	Explicitly declare and isolate dependencies	Store config in the environment

- Configuration
  - Separate from the code
  - Also separate from the application
    - i.e. DB credentials; hostnames, passwords
    - Acid test – could the code base be made open source?
    - Internal writing (i.e. Spring Configuration) considered part of codebase.
  - Environment variables recommended.

12- Factor Application

IV. Backing Services Treat backing services as attached resources	**V. Build, Release, Run** Strictly separate build and run stages	**VI. Processes** Execute app as stateless processes

- Backing Services
  - Service consumed by app as part of normal operations
    - DB, Message Queues, SMTP servers
    - May be locally managed or third-party managed
  - Services should be treated as resources
    - Connected to vis URL / Configuration
    - Swappable (change in – memory DB for MySQL)

12- Factor Application

IV. Backing Services	V. Build, Release, Run	VI. Processes
Treat backing services as attached resources	Strictly separate build and run stages	Execute app as stateless processes

- Build, Release, Run
  - Build stage – converts codebase into build (version)
    - Including managed dependencies
  - Release stage – build + config = release
    - Ready to run
  - Run – Runs app in execution environments

12- Factor Application

IV. Backing Services
Treat backing services as attached resources

V. Build, Release, Run
Strictly separate build and run stages

VI. Processes
Execute app as stateless processes

- Processes
  - One or more discrete running processes
  - Stateless
    - Processes should not store internal state (HTTP Sessions)
  - Shared Nothing
    - Data needing to be shared should be persisted
  - Memory / local tmp storage considered volatile
  - Processes may intercommunicate via messaging / persistent storage

12- Factor Application

VII. Port binding Export services via port binding	**VII. Concurrency** Scale out via the process model	**IX. Disposability** Maximize robustness with fast startup and graceful shutdown

- Port binding
  - App should not need a “Container”
    - Java App Server, Apache HTTPD for PHP …
    - PaaS now takes that role
  - Apps should export HTTP as a service
    - Define as a dependecncy (#2)

      Tornado (Python) , Thin (Ruby), embedded Jetty/Tomcat (Java)
    - Execute at runtime
  - One App can become another App’s service (#4, #6)

12- Factor Application

VII. Port binding Export services via port binding	**VII. Concurrency** Scale out via the process model	**IX. Disposability** Maximize robustness with fast startup and graceful shutdown

- Concurrency
  - Processes are first class citizens
    - Like Unix service daemons
    - Unlike Java threads
  - Individual processes are free to multithread
    - BUT a VM can only get so large (vertical scaling).
    - Must be able to span multiple machines (horizontal scaling)

12- Factor Application

VII. Port binding Export services via port binding	**VII. Concurrency** Scale out via the process model	**IX. Disposability** Maximize robustness with fast startup and graceful shutdown

- Disposability
  - Processes should be disposable
    - Remember, they're stateless!
  - Should be quick to start and stop
    - Should exit gracefully / finish current requests.
    - Or should be idempotent / reentrant
  - Enhances scalability and fault tolerance
  - Design *crash-only* software

12- Factor Application

X. Dev/ prod parity
Keep dev, staging, prod as similar as possible

XI. Logs
Treat logs as event streams

XII. Admin processes
Run admin/ mgmt tasks as one-off processes

- Development, Staging, Production should be similar
  - Dev / prod environments often different
    - Tool gap – dev use SQLLite / Nginx prod uses Apache/ Oracle
    - Personnel gap – developers develop, admins deploy
    - Time gap – (development over weeks / months)
  - Keep differences minor
    - Reduce tool gap – use same software
    - Reduce time gap – small changes & continuous deployment
    - Reduce personnel gap – involve developers in deployment and monitoring

12- Factor Application

X. Dev/ prod parity	XI. Logs	XII. Admin processes
Keep dev, staging, prod as similar as possible	Treat logs as event streams	Run admin/ mgmt tasks as one-off processes

- Logs are streams of aggregated , time –ordered events
  - Apps are not concerned with log management
    - Just write to sysout.
  - Separate log managers handle management
    - Logging as a service
- Can be managed via tools like papertrail, Splunk …
  - Log indexing and analysis

12- Factor Application

X. Dev/ prod parity Keep dev, staging, prod as similar as possible	**XI. Logs** Treat logs as event streams	**XII. Admin processes** Run admin/ mgmt tasks as one-off processes

- Admin Processes / Management Tasks Run as One-Off Processes.
  - DB Migrations, one time scripts, etc.
  - Use same environment, tool, language as application processes
    - – REPL

Read – Eval – Print Loop = command-shell for running non-interactive shell scripts

Design Guidelines

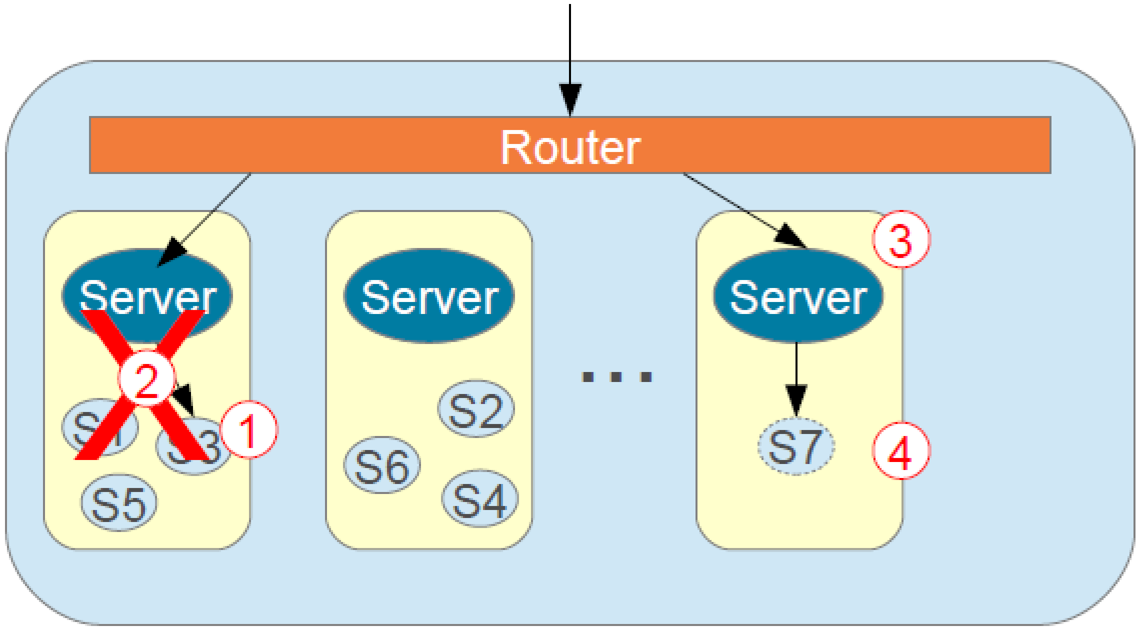
- Application Architecture
  - Application architecture concerns:
    - Load Balancing / Session Management
    - Local file system
    - Port Limitations

Load Balancing Router

- CF Router provides automatic load balancing
  - When >1 instance
  - Uses HAProxy http://www.haproxy.org
- Sticky Session – based on JSESSIONID parameter
  - Works automatically for Java Web apps
  - Other technologies need extra steps

Session Management

- Based on sticky sessions, managed by Router
- Session is NOT persisted between instances.
  - If an instance fails, those sessions are lost.



1. Requests *stick* to previous session
2. Server dies
3. New container & server started
4. New session – old session lost

Session Management

- Session use best avoided
  - In order to achieve massive scaling
  - Easy for RESTful servers
- If sessions are essential
  - Add persistent session management
    - For example: Gemfire cache
  - Move session-data to light-weight persistent store
    - Such as Redis key-value store

Local File Access

- Apps should not attempt to access the local file system
  - Short lived, not shared
- Instead, use Service abstraction when flat files are needed
  - Amazon S3, Google Cloud Storage, Dropbox or Box
    - Examples: file – uploading
  - File Storage as a Service is coming
- Or consider using database
  - Redis : Persistent, in – memory data
  - Mongo DB : JSON document storage

Logging

- Loggregator will automatically handle all output logged to sysout or syserr

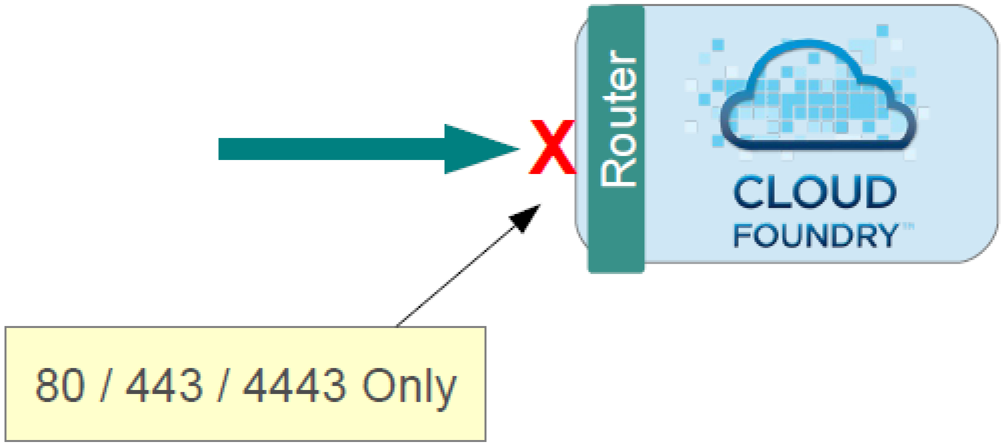
- Don’t use log – files
  - Local file system is generally not available
  - Loggregator will NOT handle files made to the file system or other sources
  - Write to sysout instead
  - Or consider writing log records to a fast, NoSql database
    - Can now be queried

Resources

- All needed resources should be available via classpath
  - Example: use **classpath** : resource in Spring
- File resource not available
  - Short lived / not shared
- Place configuration in classpath: resources
  - Spring MVC supports static web-resources in jars
    - Such as CSS, HTML, images, …

Port Limitations

- Port usage currently limited to HTTP and HTTPS
  - Only 80, 443 and 4443* open to incoming traffic
    - Outgoing traffic controlled by Security Groups
  - Cloud Foundry Router only supports these protocols



* 4443: for secure websockets

Recap

12-Factor

logging

local files

Session management

resource

port

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