CloudI

A Cloud as an Interface

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Cloudi Terminology

- Work Title == “Work Module.Tag”
- Data Title == “Data Module.Database”
- Worker – a work thread within the cloud_worker_port operating system process connected to Cloudi
- cnode – Erlang node implemented in C
- Erlang port – operating system process spawned by the Erlang VM
1. What is Cloudi?
2. Why Use Cloudi?
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What is Cloudi?

1. Private Cloud Computing Framework
2. Fault-tolerant Work Processing
3. Dynamic Load Balancing and Scheduling
4. Ordered Work Input/Output
5. Distributed Execution of C/C++ Work
A Private Cloud Computing Framework

- Provides an open-source cloud
  - BSD License
- An alternative to paying for a black-box commercial cloud
  - Internal processing is secure processing
- Creates a stable distributed processing environment from any available Linux machines
Fault-tolerant Work Processing

- Erlang/OTP coordinates all work allocation, execution, and work data flow
- Any crash of C/C++ code is handled
  - Any signals, including uncatchable signals
- Uses Erlang Port processes subscribing to the cloud as Erlang C Nodes
  - Fault-tolerance overhead ("trip1") averages 0.129 ms/task locally and 0.334 ms/task remotely (http://cloudi.org/latency/latency.html)
Fault-tolerant Work Processing (cont.)
Dynamic Load Balancing and Scheduling

- Worker threads are ideally stateless and form a pool of workers in the cloud.
- Cloudi adjusts the task size based on the task execution time that is requested:
  - Convergence is slow to avoid problems with unstable work processing.
- Cloudi verifies that work is loaded:
  - During work allocation
  - After node reconnection
Ordered Work Input/Output

- The Erlang work module enforces an order on the work task input
- Cloudi maintains the task input order when collecting output so data is stored in the same order
- Work processing is paused when excessive data accumulation occurs
Distributed Execution of C/C++ Work

- One `do_work` function is required in a dynamic library for the C/C++ work
  - Loaded when Cloudi requests it
- Six Erlang functions within the work module provide work task specification
  - The functions define the task size as a float value in the range (0..1) and task data as binary data
- Any Erlang data module can handle output
  - Currently the supported databases are PostgreSQL, MySQL, memcached, Tokyo Tyrant, and CouchDB
Why Use Cloudi?

- Computationally intensive data processing
  - Text processing, numerical computations, data transformations, and iterative methods
- Computation is decoupled from external access to the results
  - Separating the computational processes from the resulting data helps to isolate complexity and supports fault-tolerant services
A management application can facilitate failover between master nodes
  - Separate epmd processes keep the distributed Erlang nodes separate

Instance failover can currently be accomplished through manual usage of the `cloud_api` module
  - Not recommended for critical tasks
Scalability can be achieved with a combination of NoSQL and SQL databases that are clustered.
How To Use Cloudi

1. Cloudi Compilation
2. The Erlang Work Module
3. The C/C++ Work Library
4. Cloudi Configuration
5. Cloudi API
Cloudi Compilation

- Compiles g++/gcc locally for all dependencies but takes a lot of time and memory
  - More than 2 hours of compilation time
  - Approximately 3 gigabytes of hard disk storage
  - Only done the first time Cloudi is compiled

- Keeps the Cloudi alpha release maintainable and consistent for diagnosing or reporting problems
The Erlang Work Module

- Uses the `cloud_work_interface` behavior
  - `handle_get_task_time_target/0` controls the smallest interval of job output to the database
  - `handle_get_initial_task_size/0` provides the smallest possible task size for the algorithm
  - `handle_get_task/3` takes the task size and returns the binary task data with the task input database queries that must be processed by the work library
  - `start_link/2` takes job configuration arguments that define the scope of several tasks
The work module must dynamically adjust the task data in a meaningful way to avoid overloading the database(s)

- Task data must be less than 4 megabytes
- The work module must use the same name as the corresponding C/C++ work library
- A “work title” identifier is the work module name with a unique “.tag” suffix that identifies the type of tasks being processed
The C/C++ Work Library

- Uses the `cloud_work_interface` header file to define the `do_work` function
  - Provides the worker thread id for caching with global work library data
  - The “stop” boolean input parameter changes to make the running task abort its computation
  - A vector of output database queries stores the result of a `do_work` function evaluation which was directly influenced by the task data input parameter created in the Erlang work module
Any data repositories must be configured with a “data title” so that output queries are not discarded as irrelevant.

Cloudi depends on a locally compiled version of g++/gcc so that work executes in a consistent environment.

The execution time of the `do_work` function will adjust for tasks in an attempt to converge on the task time target.
Cloudi Configuration: Machines

- **Machines specification**
  - Defines the Cloudi nodes for an instance
  - Specifies the number of operating system processes to use for executing any work and how many threads to allow per process
  - Uses boost::thread to provide threading which encapsulates the pthread API on Linux
  - Specifies port numbers used for each operating system process
Cloudi Configuration: Data

- Data repository specification
  - Database specific settings where a “data title” is a data module name with a “.database” suffix to uniquely identify data routing
  - Startup requires that all databases specified are online
  - The master node for the active instance will die if the database connection is terminated or experiences a timeout
Cloudi Configuration: Jobs

- Jobs specification
  - Every entry must have a unique “work title”, i.e., a work module with “.tag” suffix
  - Includes a request for a number of workers or uses the ‘all’ atom to use all available
  - Either specifies the atom ‘threads’, ‘no_threads’, or an integer that represents threads per operating system process
  - Provides job parameters as arguments to the work module start_link/2 function
Cloudi API

- Provides a dynamic configuration for machines, data repositories, and jobs
- Uses the same specification format as used in the cloud.conf configuration file
- Does not block the removal of a data repository that running jobs depend on
- Will be the interface for an external management application
- Exists as the `cloud_api` Erlang module
The Future

- The management application needs to be created to simplify Cloudi instance failover
- More databases will be supported
- More fault-tolerance testing
- Download Cloudi @ http://cloudi.org/
  - Version 0.0.9 alpha is now available!
Questions?