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Master Thesis

Building a Package Manager for Jolie

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April 28, 2017

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2.3 Introduction to Jolie

Jolie is a service-oriented programming language, and is build to support a microservice natively. In this section we will cover what kind of language Jolie is, and how it is currently used.

Jolie has a C-inspired syntax, and is dynamically typed. Its interpreter is written in Java.

The language has no native functions or methods, but instead works in processes. A process has no arguments, and does not contain any stack (in the case of recursive calls). There are two pre-defined processes, which will always be called by the interpreter, these are called `init` and `main`.

```
1  include "console.iol"
2
3  define PrintOutput {
4      println@Console(output)() // Prints 'OK'
5  }
6
7  init { a = 1 }
8
9  main {
10     b = 2;
11     c = a + b; // c = 3
12     if (c == 3) {
13         output = "OK"
14     } else {
15         output = "Bad"
16     };
17     PrintOutput // Calls the defined process 'PrintOutput'
18 }
```

Listing 1: A very simple Jolie program

Listing 1 shows a very simple programming language, in what looks like what you might expect from a dynamic language with C-inspired syntax. However a few things may also strike you as odd.

First of all there are typos on lines 12, 14 or 16, the semicolon is not needed here, in fact it would be a syntax error. The reason for this is that the semicolon isn't used strictly for parsing purposes, but it instead for having multiple statements in a process. The "semicolon" statement, also called a sequence statement, has a syntax of `A ; B`, which should be read as: first perform statement `A`, then perform `B`. The sequence statement requires both of the operands to be present, hence the syntax error. Another similar statement is the parallel statement, which has a syntax of `A | B`, which reads as: do `A` and `B` in parallel. Using these operators together allows the programmer to easily create a fork-join workflow. This is typically used in microservices when we want to collect data in parallel, and continue once all of the data has been retrieved.

Secondly has slightly different rules for scoping. In Jolie everything not defined in the global scope goes into the same scope. This also persists through calls to defines. This is the reason that `PrintOutput` can use the output variable.

Several execution modes exists. The default execution mode, which was used in Listing 1 is `single`. This means that the `main` process is run just a single time. Two more modes exists, those being `concurrent` and `sequential`. TODO Some more stuff

Ports are the primitive that Jolie uses for communication, two types of ports exists: input and output. Ports describe a running service, where it is located (`Location`), and how to speak to it (`Protocol`), and finally which operations it supports (`Interfaces`). In Listing 2 we see a simple output port which contacts `example.com` on port 42000, using `http`. Note that it is only the ports that deal with the protocol, everything inside of the code is completely agnostic with respect to the protocol being used for communication. As a result it is easy to change a service from communicating using one protocol to another.

```
outputPort Example {
    Location: "socket://example.com:42000"
    Protocol: http
    Interfaces: IExample
}
```

Listing 2: A simple output port which contacts the Google website

The interface which the port uses is called `IExample`, a full definition of it can be seen in Listing 3. Two types of operations exists in Jolie, namely `RequestResponse` and `OneWay`. The difference being fairly self-explanatory, the first receives a request and returns a response, the other simply receives a request, and produces no response.

```
interface IExample {
    RequestResponse:
        anOperation(RequestType)(ResponseType)

    OneWay:
        hello(HelloType)
}
```

Listing 3: An interface in Jolie defines which operations a port exposes

Whenever the Jolie interpreter invokes an operation on an output port, or receives a request on an input port, the types will be checked. This check ensures that we don't send out incorrect requests, and ensures that we do not attempt to process an incorrect request. Listing 4 show the request and response type of `anOperation`.

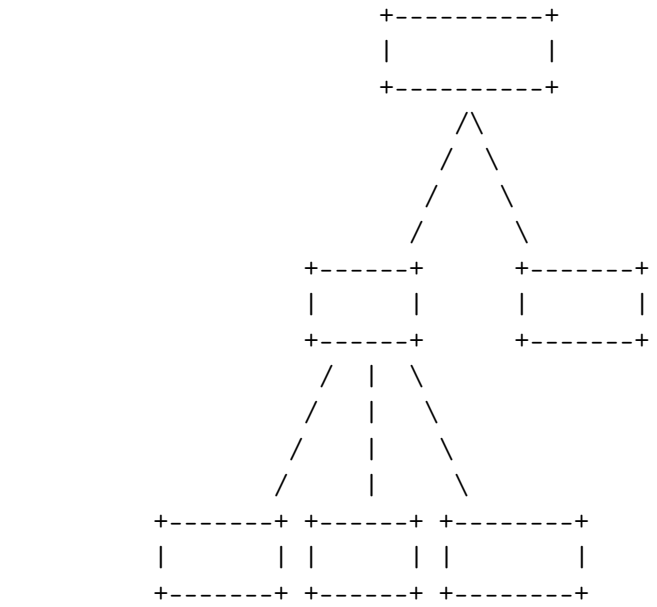
```
type RequestType: void {
    .a: int
    .b: string
    .c: bool
    .d: double
    .e: any // any primitive type
}

type ResponseType: int {
    .aFixedArray[1, 3]: string
    .aNonFixedArray[0, *]: string
    .fieldWithChildren: void {
        .a: void {
            .b: int
        }
    }
}
```

Listing 4: Jolie types are tree-like structures

In Jolie types are tree-like structures, very similar to how, for example, XML would be represented. Importantly the root may also contain a value, this is different from how most other programming languages work. This also means that certain encodings may have problems with this. JSON a popular format for serialization does not support root values, as a result Jolie will encode the root value under a special key to work around this fact.

TODO Actually use this illustration for something, should probably work with the actual example provided.



Jolie natively supports a variety of techniques for composition of services. The most important (for this work), which we will cover here are **aggregation** and **embedding**.

Embedding allows for a larger service to run smaller services as inner components. These services communicate with each other using more efficient local communication. These embedded services can be other Jolie services, but may also be services written in, for example, Java or even JavaScript. Communicating with these services is done exactly the same way as with any other service, it is entirely transparent to the application code where the service is located. TODO Can probably say a few more words about this subject. Might be easier to add this later when we know what we actually need.

Aggregation is a generalisation of proxies and load balancers. An illustration of this concept can be seen in Figure 2.1. Aggregation is useful for creating a wide variety of proxy like architectural patterns. The aggregation feature is often used along side the courier and interface extender features. Couriers allows the developer to insert code in-between the receiving the request and forwarding it. These features for example allow you to add authentication to a service which otherwise doesn't have it. This is done entirely without having to touch the original service.

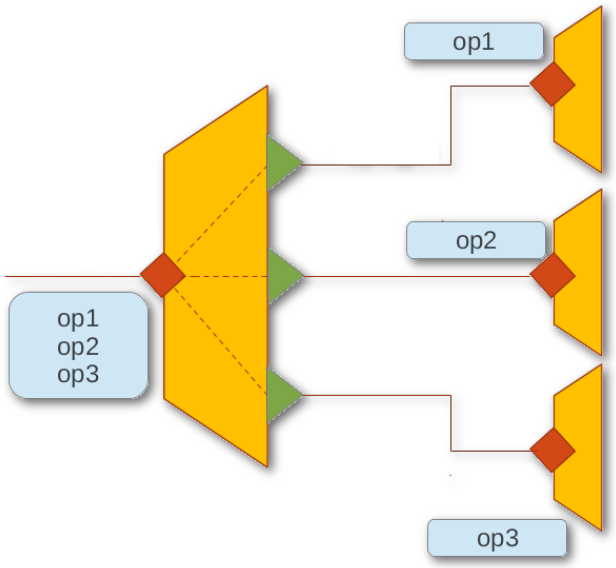


Figure 2.1: Aggregation is a generalisation of proxies and load balancers

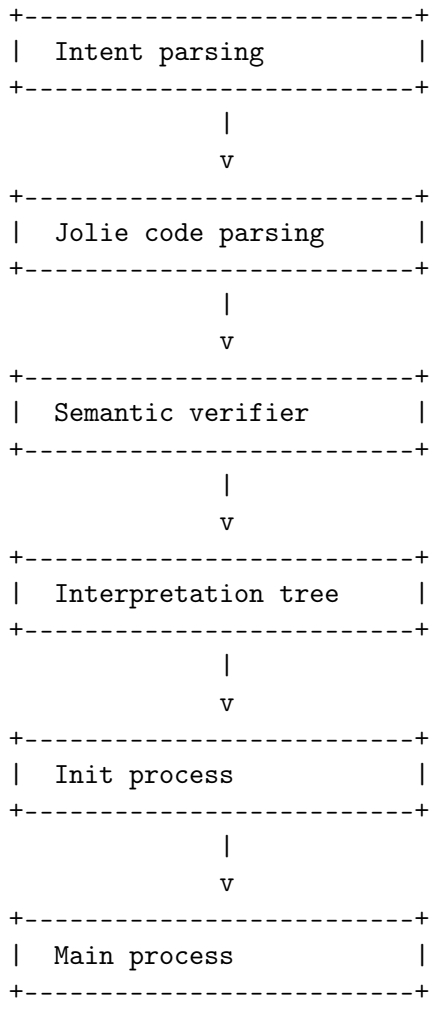
2.4 The Jolie Engine and Interpreter

- Values and types
- Phases of the compiler
- Anything we need to explain the changes that were made

In this section the internals of the Jolie engine will be introduced. This should give the reader the necessary knowledge to understand the changes made to support a module and package system for Jolie.

At the core of the Jolie engine is the interpreter. Each interpreter is responsible for parsing and executing a Jolie program. A single engine may run several instances of the interpreter, this is most commonly the case when embedding several other Jolie services.

A simplified view of the Jolie interpreter's pipeline can be seen in Figure 5.



Listing 5: A simplified view of the Jolie interpreter pipeline

The first phase of the interpreter is parsing the intent. In this phase we essentially figure out why the interpreter has been created, and what actions it should perform.

The Jolie engine can be invoked from the command-line, the command-line is the source of the intent which starts the first interpreter. The syntax for the command line is (roughly) as follows: `jolie [commands and options] <program> [program arguments]`. The options passed change the overall behaviour of the engine, and all interpreter instances share these. Commands and program arguments, however, only belong to the interpreter that they were originally passed.

The intent parsing phase is also responsible for locating and retrieving the program used. This is passed to the program parser. The program parser is the second phase, and is responsible for creating the Abstract Syntax Tree (AST) which represents the input

program. The parser will produce only a single root node, namely the `Program` node. As a consequence of this, any file which is included is semantically identical to copying and pasting the source code of that file into the original file, in place of the include statement. It should also be noted that include paths are *not* relative to the file that includes, but rather relative to the current working directory (i.e. where the engine was started).

The third phase traverses the AST to make sure that it is semantically valid. This weeds out programs which are syntactically correct, but do not make sense. The amount of work done in this phase is somewhat limited, given the otherwise dynamic nature of the language.

Given a semantically valid AST the interpreter is ready to build the interpretation tree. The interpretation tree contains new nodes, known as processes. Each of these processes can be run, to execute the correct behaviour.

Once the interpretation tree is build, we're ready to execute the actual code (which lives in the interpretation tree). First the init block is run, followed by the main block.

2.5 A Complete Application with Jolie

In this section we will describe a complete application written in Jolie. The application will contain several services, and will be written using best practices from before the module and package system.

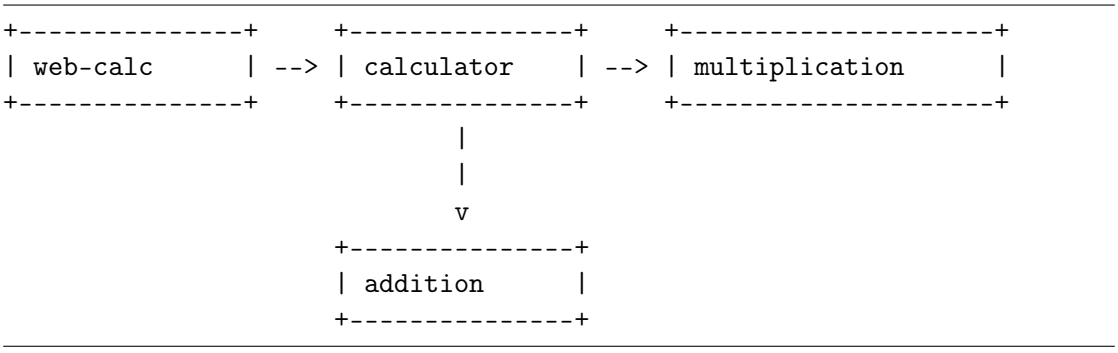
Along the way several patterns used for re-using code will be highlighted. This will serve as the core motivation for our solution.

2.5.1 Architecture

The application we will be building is a very simple calculator system. The architecture of our application is shown in Figure 6 we see an illustration of the system's architecture.

The calculator service will provide various operations for applying an operator on a sequence of numbers. In order to perform this, highly complex, action of applying these operators, the calculator will contact other microservices.

The dashed region (TODO) displays services that should be running in the same Jolie engine. This is accomplished via embedding, which was introduced in a previous section.



Listing 6: The Architecture of a Simple Microservice System

2.5.2 Implementing the Calculator Service

We will keep our focus on the *calculator* service, and its interacting with other services. Putting together the stuff learned from the previous sections, we can quickly setup an input port for the service, which has the appropriate interface. It is considered best practice to place the public interfaces that a service exposes in its own separate file. Files intended for other services to include typically have the file extension `.iol` as opposed to `.ol`. There is no technical difference between the two, but it allows for the developer to more easily express intent. Files that are included can be placed in the `include` directory, this directory is always implicitly added to the search path.

Thus in order to implement our calculator service we create two files, one for the service implementation (`calculator.ol`), and another which can be used by other services (`calculator.iol`). The implementation and interfaces are shown in Listing 7.

```
// calculator.ol
include "console.iol"

inputPort Calculator {
    Location: "socket://localhost:12345"
    Protocol: sodep
    Interfaces: ICalculator
}

main {
    [sum(request)(response) {
        println@Console("Implementation
        ↪ goes here")()
    }]

    [product(request)(response) {
        println@Console("Implementation
        ↪ goes here")()
    }]
}
```

```
// calculator.iol
type Numbers: void {
    .numbers[2, *]: int
}

interface ICalculator {
    RequestResponse:
        sum(Numbers)(int),
        product(Numbers)(int)
}
```

Listing 7: TODO Caption

Observation 1. The interfaces and types of a service are typically separated into their own files. This files typically has the extension `.iol` to indicate that it does not contain a service implementation, but is rather intended for inclusion by a service which requires it.

This file is typically put in the `include` directory. This directory is always added to the search path natively by the Jolie engine.

The operations that the calculator exposes, needs to collaborate with the other services. In order for us to speak to them they need output ports.

First of all the output ports needs interfaces. Like we did with the calculator service, the other services have exposed their interfaces in a special file intended for inclusion. As a result we will have to copy the `.iol` files of these services into our own.

Secondly these output port needs to be reached. We can either embed the services, making it run inside of the same Jolie engine as our calculator service, or we can provide external bindings to it. For output ports we may change this binding dynamically at runtime. Note that this is unlike input ports which must be ready at deployment time.

Binding an output port to an external service is relatively easy. For example to let the `multiplication` port bind to a service using https, we might write `Location: "socket://mult.example.co`

and `Protocol: https`. The input port at the multiplication processor would also have to match this, to ensure it runs on the correct port and speaks the correct protocol.

It is a similar to bind an output port to an embedded service. However this is done by setting the `Location` or `Protocol` attributes. We must instead instruct the engine to embed the service, which most importantly requires us to point to some executable service. The Jolie engine supports several language for these embedded services, including Jolie, Java, and JavaScript. For our desired deployment, we wanted to embed the addition service inside of the calculator service. Assuming that the addition service is written as a Jolie service, and its service is implemented in `addition.ol`, then we may create an embedding as shown in Listing 9. Just like in the case of the external services, the input port of the receiving service *must match*. In the case of embedded service there must be an input port listening on the `"local"` location.

Quite often the location of an input port is considered a deployment problem. We see this quite clearly in the case of embedding a service. All current solutions in Jolie, require us to *modify the source code of a service*, simply to change where the service should listen. Best practices in Jolie attempt to make this less of a problem by including a configuration file which contains constants. The addition service, might include a file called `addition.iol` with constants setting up the location and protocol of the service. An example of this is shown in Listing 8.

```
// addition.ol
include "addition.iol"

inputPort Addition {
    Location: ADDIITON_LOCATION
    Protocol: ADDIITON_PROTOCOL
}
```

```
// addition.iol
constants {
    ADDIITON_LOCATION = "local"
    ADDIITON_PROTOCOL = sodep
}
```

Listing 8: A common Jolie practice for solving configuration of a service, is to include a file containing constants with the desired configuration.

Observation 2. Most configuration of Jolie services are done via constants. Jolie constants, different from most other languages, can be simple literal types, or they may even contain identifiers. This makes them rather versatile in what they may configure.

The constants are placed in a separate source file, which is included by the service requiring the configuration.

```
embedded {
    Jolie:
        "addition.ol" in Addition
}
```

Listing 9: Embedding the `addition` service in the `Addition` output port

With the code from Listing 7 where the output port `Console` is defined. The output port points to an embedding of the console service, and is included directly in the `console.iol` file. This is a fairly common pattern used in Jolie, especially for services that work in a library-like fashion (i.e. not intended as a stand-alone service). This pattern is used for almost every single service in the Jolie standard library.

> **Observation 3.** Services intended to be used as libraries are often contained in a single `.iol` file. This file contain everything required to set it up, included interfaces, types and an embedded output port.
>
> This makes it very easy to use the service, however it also makes it impossible to bind to this service externally, without first getting an embedding. This isn't possible since we cannot include the interfaces and types by themselves.

With the output ports correctly configured, we may now implement the actual business logic for our calculator. For completeness sake this might look like shown in Listing 10.

```
[sum(request)(response) {
    total = 0;
    for (i = 0, i < #request.numbers, i++) {
        // Add current number with total, and store result in total
        add@Addition({
            .a = total,
            .b =  request.numbers[i]
        })(total)
    };
    response = total
}]
```

Listing 10: Implementing the checkout operation

Finally we want to reflect slightly on the file structure that this service ended up having. In order to use external services, we had to include files which contain these interfaces. This version is worse when an embedding is desired, since the entire service with its implementation is suddenly required.

The files from these external service are also hard to manage. It isn't possible to simply move the source code of a service into its own directory. This is not possible since includes, unlike in most other languages, are not relative to the file performing the include, but rather relative to the project level root. Thus if we wish to move the service to a new directory, all includes in the source code would have to be updated. A common result of this is that every single file gets dumped into the project level root. When all files are stored in the same directory, we also get a much larger chance of having name conflicts. As a result names tend to become rather large, to make it less likely that a conflict occurs.

The final file structure of the calculator service is shown in Listing 11.

```
.
+-- include
|   +-- calculator.iol
|-- addition.iol
|-- addition.ol
|-- multiplication.iol
+-- calculator.ol
```

Listing 11: File structure of the calculator service

Observation 4. In order to collaborate with other services, it is often needed to manually copy files into the service. The files required depend on if an embedding is required, when an embedding is required we will need the entire service (and any services it may depend on itself). If we just need to interface with it, we can simply include the files required for its interface files.

Structuring the files is problematic, due to `include` statements not being relative to file performing inclusion.

Jolie Modules

3.1 Summarizing the Problem

The goal of this thesis is to promote, and facilitate better code reuse in Jolie. In Section 2.5 we showed how a typical Jolie service would be written, and summarized a number of patterns we have observed.

3.2 Modules

A module in Jolie is defined as a project root directory, and optionally an entry-point. Modules are uniquely identified by a name.

The Jolie engine needs to know about these modules. The engine is informed about these modules from the intent as options which starts the engine (command-line arguments). This information is collected in the "intent parsing" phase, and is made available to any later phase that might need it. This intent is passed as an option, recall that options are shared among all interpreter instances inside of an engine. As a result any embedded service will also be aware of the same modules.

As an example, we may inform the engine about a module called "foo", which has its source code placed in `/packages/foo` with an entry-point in `/packages/foo/main.ol` we would write: `--mod foo,/packages/foo,main.ol`. This implementation technique is very close to how, for example, you would add a JAR file to the classpath of a Java program.

The result of this decision is that quite a lot of additional options may need to be passed to the engine. However this choice was purposely chosen, it is left for another tool to make this job easier. In this case a package manager is expected to take the heavy lifting, and figure out which modules exists. Requiring complete knowledge to be passed to the engine, allows for more freedom in how these tools are implemented, and another implementation strategy, than the one provided in the package manager, could be created without any changes to the language infrastructure. See Section TODO about how the package manager passes this information to the engine.

To allow for better organization, a new type of include has been added to the language. These include allows the developer to include from a particular package. The syntax of

this include is shown in Listing 12. When a package include is used, the search path will be altered, such that the project root is changed to that of the package (as opposed to where the engine was started). Any file included from within this package should perform its includes relative to its own root, rather than the project root.

TODO Example

The new include syntax, along with native support for modules, allows for the code to properly organized. With this a module may be placed inside of its own directory, without any of the code having to be changed.

```
1 include "<file>" from "<module>"
```

Listing 12: Extension to the include statement, made for module imports

3.2.1 Include Algorithm for Jolie

TODO To this date I still don't understand how the include algorithm works. Ask Fabrizio about this.

3.2.2 Module Include Algorithm

TODO Module includes modify the search path. This also means the injection of the include directory, which is used as a convention. This helps maintain expected behaviour.

TODO In order to implement the root switching we use a stack.

3.3 Configuration

3.3.1 Motivation

From observation 2 we saw that most configuration was done via the inclusion of source code. This source code would expose constants (read: literal values *and* identifiers). The included source code, however, can do anything that Jolie source normally can, and isn't limited to just the desired configuration. As a result, a service developer cannot be certain that the configurator (entity who provides configuration) doesn't start messing with other details of the program. Deploying defensive programming[1] techniques against

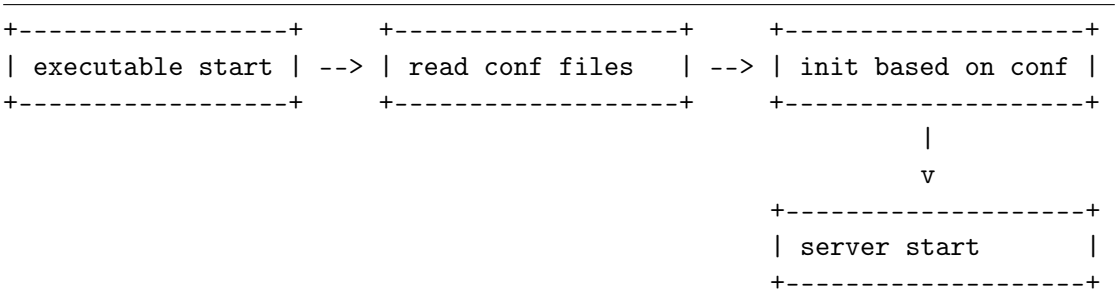
[1] Defensive programming techniques are usually employed for systems that require high availability, or where safety and security is required.

this becomes significantly more problematic, since no guarantees about the configuration source file can really be made.

Distributing re-useable packages is also problematic with this approach. Several features of package management namely requires that the package remains read-only. Features that typically need this aspect could be updating, without this we would need source-code merges, or integrity checks of packages.

We also saw that a lot of issues, that should have been purely deployment, became a code problem.

This gives us plenty of reason to explore the need for a configuration format. Most other systems, typically frameworks, would most likely go for a system defined in code, as opposed to natively in the language. Such as a system would most likely read configuration files from some external format, such as XML. Once these files are parsed, the system may perform some actions based on this, and then finally the server could start. This sort of system is illustrated in Figure 13.



Listing 13: Typical configuration system TODO Replace with concrete example

However implementing such as a system in Jolie has its problems, most of these come from the difference between the underlying programming languages.

In the case of most microservices frameworks, they are written in general purpose languages. These languages are not made to support native constructs needed for microservices, but rather made to support a more wide range of applications. This means that any such construct made to support a microservice architecture are created entirely in code. As a result, configuring these can easily be done, since the framework has complete control over the components the system is made up of.

However in a specialized programming language, like Jolie, the constructs making up the system are managed by the language. As a result user code does not have complete control over these constructs, only the language has this. For example, user code in Jolie has limited control over how networking is performed, it may guide the Jolie engine on what messages should be send, but it is entirely up to the engine how it should be done. In a similar fashion, Jolie constraints certain constructs to be ready at deployment time.

This makes it impossible to perform configuration from user code, since this wouldn't happen until run time. Concrete examples of this includes the input ports, which needs to be ready at deployment time. Thus without native support for configuration of these, it would not be possible to change the input port.

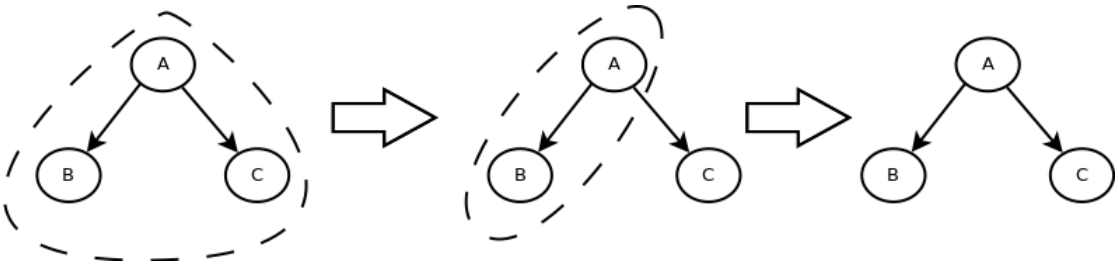
3.3.2 Configuration Profiles

3.3.3 Configuration File Format

3.3.4 Changes to Core Language

3.3.5 Example

TODO This is just copy pasted from some markdown document. Might be able to find a better example. Syntax is most likely also outdated.



(The dashed region corresponds to which services that are embedded together)

This use-case is intended to show how we can easily go from a prototype where we embed everything (this is easier to run locally) to hosting each service by itself.

```
1  // A.ol
2
3  ext outputPort A {
4      Interfaces: AIface
5  }
6
7  ext outputPutPort B {
8      Interfaces: BIface
9  }
10
11 constants {
12     FOO: int
13 }
```

```
// A.col

include "B.col" // The includes work just like they do in Jolie
include "C.col"

// Previously called namespace. Configures makes it more explicit that we're
// talking about a specific package and not an arbitrary name
configures "A" {
    // Like always we just put the definitions here
    FOO = 42

    // We alter the syntax slightly for output ports being embedded
    outputPort B embeds B
    // The second B refers to the profile B (if no profile is specified it gets
    // the same name as the package it configures). This means that this
    // configures block also has name "A". It could also have been written as:
    // `profile "A" configures "A"`

    outputPort C embeds C
}
```

Note: The previous proposal did not allow for embedding of services directly from the configuration. This is however needed since packages by themselves should be considered read-only. Thus if we want to configure a package to embed its dependencies, then this must be done from external configuration, we cannot do this in source.

```
// B.col

configures "B" {
    inputPort B {
        Location: "local"
    }
}
```

```
// C.col

configures "C" {
    inputPort C {
        Location: "local"
    }
}
```

In order to use an external B we need to update "A.col":

```
// A.col
include "C.col"

configures "A" {
    outputPort B {
        Location: "socket://b.example.org:8000"
        Protocol: sodep
    }
    outputPort C embeds C
}
```

In order to update the deployment file of B we simply need to update the input port to no longer be local.

```
// B.col
configures "B" {
    inputPort B {
        Location: "socket://localhost:8000"
        Protocol: sodep
    }
}
```

In most cases however this would be unnecessary since the default configuration file for "B" could already include a default input port.

In that case we could simply deploy directly from the default configuration. The restriction on configuration units to only configure a single package helps a lot. This restriction means that we cannot from any node configure any other node which isn't a direct child of it. Without this we wouldn't be able to easily swap out one configuration unit for another.

3.3.6 Changes to the Interpreter's Pipeline

Package Manager

4.1 Packages

A Jolie Package is an extension of a Jolie Module. Recall that a Jolie Module was defined as a collection of resources, a name, and optionally an entry-point for the module. A package extends this concept by adding information required for package management.

A Jolie Package is described by a package manifest. The package manifest is a JSON file, which is always placed at the root of the package, and must be called `package.json`. The fixed location allows for the package manager to easily identify a package. The JSON format was chosen as it plain-text, and easy to both read and write for both humans and machines.

In listing 14 we show a simple package manifest. This manifest showcases the most important features of the manifest.A complete specification of the package manifest format can be seen in Appendix A. The service that this manifest describes is shown in figure 15.

```
{
    "name": "calculator",
    "main": "calc.ol",
    "description": "A simple calculator service",
    "authors": ["Dan Sebastian Thrane <dathr12@student.sdu.dk>"],
    "license" "MIT",
    "interfaceDependencies": [
        { "name": "math", "version": "1.0.0" }
    ],
    "dependencies": [
        { "name": "sum", "version": "1.2.X" },
        { "name": "multiplication", "version": "2.1.0" }
    ]
}
```

Listing 14: A Simple Package Manifest

```
+--------------+     +-------+
|              | ==> |  sum  |
|              |     +-------+
|  calculator  |
|              |     +------------------+
|              | ==> |  multiplication  |
+--------------+     +------------------+
```

Listing 15: A Calculator Service

Lines 2-3 take care of the module definition. The remaining attributes, however, are entirely unique to packages. Some attributes included in the manifest are there for indexing and discoverability purposes, examples of such attributes are shown in lines 4-6. The rest of the document describes the dependencies of this package.

A JPM dependency is defined as a "code dependency". What this means is that the dependencies listed, should only be packages that we depend on for code. This might be different from the typical definition in microservices. For example, one might state that the calculator also has a dependency on the client who speaks to it. In JPM however, we will not need to list the client, as we do not depend on any code that the client has (in fact we know nothing about how the client works).

JPM deals with two different types of dependencies: interface dependencies, and ordinary dependencies. These two serve similar, but slightly different purposes, and all depends on how the dependency is to be used.

An ordinary dependency should be used if we wish to use the code of some other service, and want to option of embedding it. This will tell JPM to download both ordinary dependencies, as well as interface dependencies.

Interface dependencies are instead dependencies that are only required to interface with the package itself, and dependencies we need to interface with others. An interface dependency will only cause us to download the interface dependencies of each sub-dependency.

The interface dependency type isn't common in other package managers, but having multiple types of dependencies is fairy common. For example, a package manager might provide dependencies which are only used during testing, we see this in Maven, or it might provide dependencies only used during development, seen in NPM.

4.2 Architecture

The entirety of the ecosystem around JPM is written in Jolie, using the features that the Jolie Module System provides, along with the features that JPM itself provides.

At the ten-thousand foot view of the architecture, it consists of three core services, as shown in figure 16:

1. **Registry**: Responsible for serving packages known to the registry.
2. **JPM**: Provides the back-end of JPM. This includes communication with one, or more, registries, for example to download packages.
3. **CLI**: Provides the front-end of JPM. The front-end is responsible for displaying a user-facing interface, and will communicate with the back-end to perform the actual work.

```
+-----------+     +-------+     +------------+
|  jpm-cli  | ==> |  jpm  | ==> |  registry  |
+-----------+     +-------+     +------------+
```

Listing 16: Ten-thousand foot view of the JPM architecture

4.3 Registry

Stuff we need to cover in this section:

- Core responsibilities, such as: publish and download
- Secondary responsibilities: Package information and dependencies
- Tertiary responsibilities: Users and groups
- Once responsibilities are in place we should talk about how we split up the workload.

4.4 Authorization

In this section we need to discuss:

- Access control matrix, and how that stuff works.
- User registration and best practices for handling passwords

4.5 The Command Line Interface

We need to cover:

- Basic introduction of how to use the tool (we need this)

- Internal organization (commands)
- Technical architecture, and deployment
- Kind of wrap up how the entire thing works here

4.6 Integrity Checks

This is a section about integrity checks in JPM.

- Some background about checksums (probably)
- How we do it. Reason we don't go for something like code signing (in pkg manager)
- Code signing, and why we would prefer this.

Appendix

A.1 Appendix A: JPM Manifest Specification

This document covers the specification of the file which defines a package. The format used for this document will be JSON, but the format and whether or not to allow for several documents is still up for discussion. For now we should avoid using any features which the generic Jolie value cannot support.

A.1.1 Purpose

The purpose of the package document is to define what a package is. Every Jolie package will contain such a document, and it describes several important properties about the package. These properties are described in the section "Format and Properties".

A.1.2 Table of Contents

A.1.3 Format and Properties

name

Name: `name`

Optional: false

Type: `string`

Description: The `name` property uniquely defines a package in a registry. Every registry must only contain a single package with a given name.

Rules:

- The name of a package is *not* case-sensitive
- The length of a name is less than 255 characters
- Names are US-ASCII
- Names may only contain unreserved URI characters (see section 2.3 of RFC 3986)

If any of these rules are broken the JPM tool should complain when *any* command is invoked. Similarly a registry should reject any such package.

version

Name: `version`

Optional: false

Type: `string`

Description: This property describes the current version of this package.

Rules:

- The version string must be a valid SemVer 2.0.0 string (see http://semver.org/spec/v2.0.0.html)

license

Name: `property_name`

Optional: false

Type: `string`

Description: Describes the license that this package is under.

Rules:

- Must be a valid identifier. See https://spdx.org/licenses/

authors

Name: `authors`

Optional: false

Type: `string|array<string>`

Description: Describes the authors of this package

Rules:

- The array must contain at least a single entry
- Each entry should follow this grammar:

```
name ["<" email ">"] ["(" homepage ")"]
```

private

Name: `private`

Optional: true

Type: `boolean`

Description: Describes if this package should be considered private. If a package is private it cannot be published to the "public" repository.

Rules:

- By default this property has the value of `true` to avoid accidential publishing of private packages.

main

Name: `main`

Optional: true

Type: `string`

Description: Describes the main file of a package.

Rules:

- The value is considered to be a relative file path from the package root.

dependencies

Name: `dependencies`

Optional: true

Type: `array<dependency>`

Description: Contains an array of dependencies. See the "dependency" sub-section for more details.

Rules:

- If the property is not listed, a default value of an empty array should be used

dependency

Type: `object`

Description: A dependency describes a single dependency of a package. This points to a package at a specific point on a specific registry.

name **Name:** `name`

Optional: false

Type: `string`

Description: Describes the name of the dependency. This refers to the package name, as defined earlier.

Rules: A dependency name follows the exact same rules as a package name.

version **Name:** `version`

Optional: false

Type: `string`

Description: Describes the version to use

Rules:

- Must be a valid SemVer 2.0.0 string
- (This property follows the same rules as the package version does)

registry **Name:** `registry`

Optional: true

Type: `string`

Description: This describes the exact registry to use. If no registry is listed the "public" registry will be used.

Rules:

- The value of this property must be a valid registry as listed in the `registries` property.

registries

Name: `registries`

Optional: true

Type: `array<registry>`

Description: Contains an array of known registries. See the registry sub-section for more details.

Rules:

- This property contains an implicit entry which points to the public registry. This registry is named "public".

registry

Type: `object`

Description: A registry describes a single JPM registry. A JPM registry is where the package manager can locate a package, and also request a specific version of a package.

name **Name:** `name`

Optional: false

Type: `string`

Description: This property uniquely identifies the registry.

Rules:

- A name cannot be longer than 1024 characters

- The name cannot be "public"
- No two registries may have the same name

TODO:

- Encoding of name
- Should the length limit be dropped? There is no technical reason for the limit

location **Name:** `location`

Optional: false

Type: `string`

Description: Describes the location of the registry.

Rules:

- Must be a valid Jolie location string (e.g. "socket://localhost:8080")