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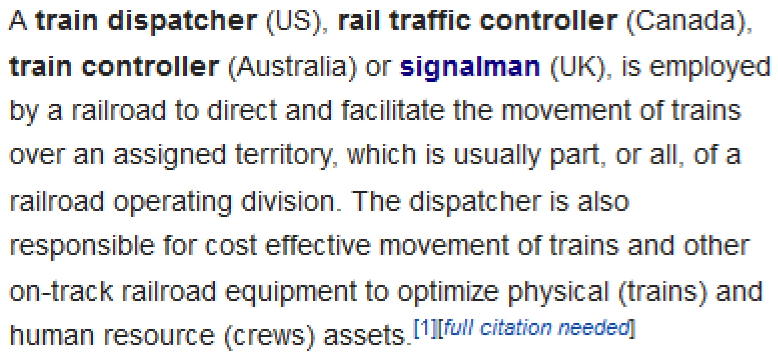
Software Engineering and Architecture

Broker II: Dispatching

Dispatching



A **train dispatcher** (US), **rail traffic controller** (Canada), **train controller** (Australia) or **signalman** (UK), is employed by a railroad to direct and facilitate the movement of trains over an assigned territory, which is usually part, or all, of a railroad operating division. The dispatcher is also responsible for cost effective movement of trains and other on-track railroad equipment to optimize physical (trains) and human resource (crews) assets.[1][*full citation needed*]

In computing, *dispatchers* are responsible for distributing incoming messages efficiently

Invoker Becomes *The Blob*

- Consider HotCiv's Invoker's 'handleRequest':

```
// === GAME
if (operationName.equals(MarshallingConstants.GAME_GET_PLAYER_IN_TURN)) {
  ...
} else if (operationName.equals(MarshallingConstants.GAME_END_OF_TURN)) {

  [lots of more if clauses removed]

  // === UNIT
} else if (operationName.equals(MarshallingConstants.UNIT_GET_OWNER)) {

  [lots of more if clauses removed]

  // === CITY
} else if (operationName.equals(MarshallingConstants.CITY_GET_OWNER)) {
  ...
```

HotStone equivalent: Game, Card, Hero

Blobs do not scale

- Consider 20 remote roles
  - Thus the invoker handles twenty different *servant classes*
- ... With each 10 methods
  - Thus the invoker handles 200 methods...

- **That is an ‘if () else if () else if() else if()’ with 200 branches... ☹**

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Composition!

- *Favor object composition*
  - *Instead of one object doing it all, delegate to specialists*
  - *Let someone else do the dirty job*

- Insight:

Let us have *one Invoker per role* in the system. Let a ‘root invoker’ determine which invoker to delegate to.

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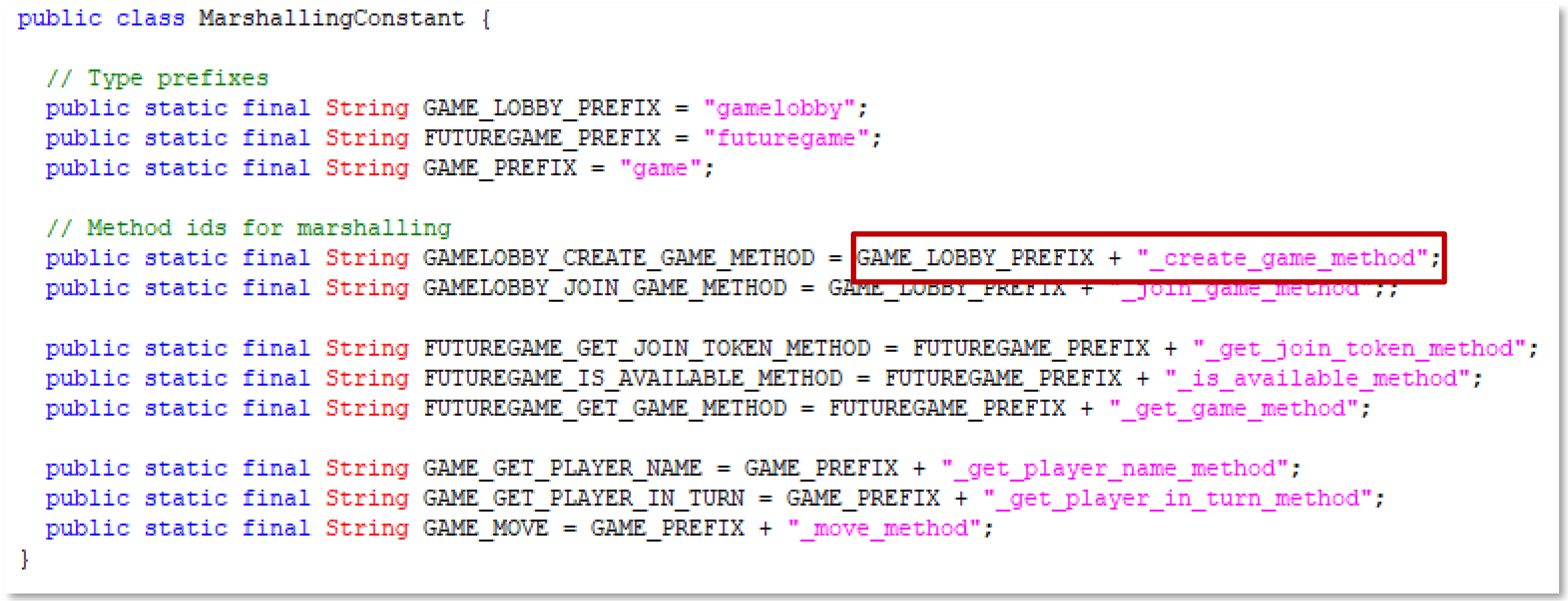
Marshalling Matters

- So, I have actually prepared for this in my marshalling
  - Three classes and *three prefixes on the method names*



```
public class MarshallingConstant {

  // Type prefixes
  public static final String GAME_LOBBY_PREFIX = "gamelobby";
  public static final String FUTUREGAME_PREFIX = "futuregame";
  public static final String GAME_PREFIX = "game";

  // Method ids for marshalling
  public static final String GAMELOBBY_CREATE_GAME_METHOD = GAME_LOBBY_PREFIX + "_create_game_method";
  public static final String GAMELOBBY_JOIN_GAME_METHOD = GAME_LOBBY_PREFIX + "_join_game_method";

  public static final String FUTUREGAME_GET_JOIN_TOKEN_METHOD = FUTUREGAME_PREFIX + "_get_join_token_method";
  public static final String FUTUREGAME_IS_AVAILABLE_METHOD = FUTUREGAME_PREFIX + "_is_available_method";
  public static final String FUTUREGAME_GET_GAME_METHOD = FUTUREGAME_PREFIX + "_get_game_method";

  public static final String GAME_GET_PLAYER_NAME = GAME_PREFIX + "_get_player_name_method";
  public static final String GAME_GET_PLAYER_IN_TURN = GAME_PREFIX + "_get_player_in_turn_method";
  public static final String GAME_MOVE = GAME_PREFIX + "_move_method";
}
```

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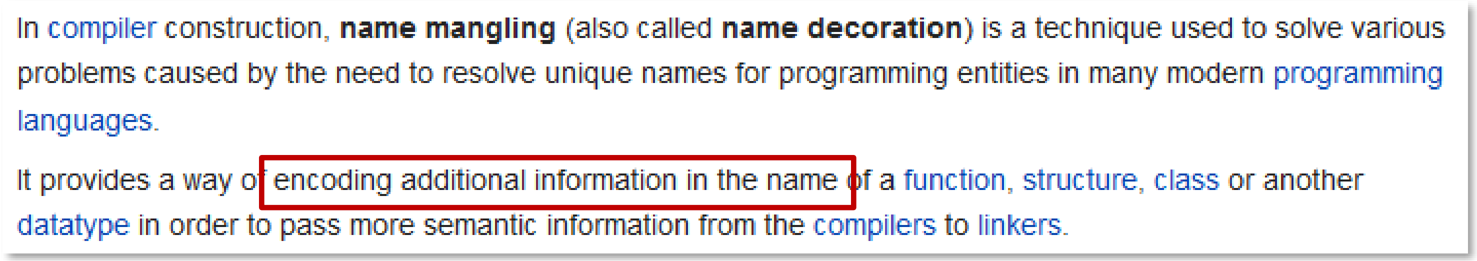
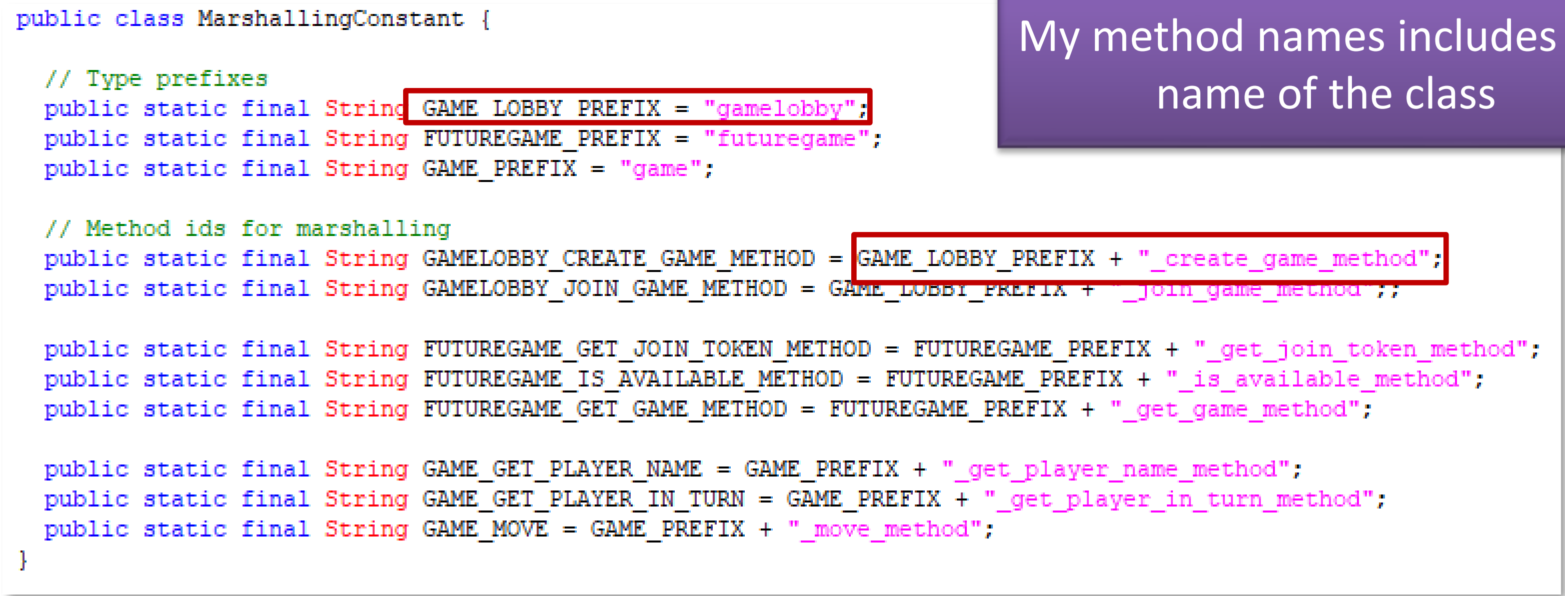
Name Mangling



In compiler construction, **name mangling** (also called **name decoration**) is a technique used to solve various problems caused by the need to resolve unique names for programming entities in many modern programming languages.

It provides a way of encoding additional information in the name of a function, structure, class or another datatype in order to pass more semantic information from the compilers to linkers.



```
public class MarshallingConstant {

  // Type prefixes
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  public static final String FUTUREGAME_PREFIX = "futuregame";
  public static final String GAME_PREFIX = "game";

  // Method ids for marshalling
  public static final String GAMELOBBY_CREATE_GAME_METHOD = GAME_LOBBY_PREFIX + "_create_game_method";
  public static final String GAMELOBBY_JOIN_GAME_METHOD = GAME_LOBBY_PREFIX + "_join_game_method";;

  public static final String FUTUREGAME_GET_JOIN_TOKEN_METHOD = FUTUREGAME_PREFIX + "_get_join_token_method";
  public static final String FUTUREGAME_IS_AVAILABLE_METHOD = FUTUREGAME_PREFIX + "_is_available_method";
  public static final String FUTUREGAME_GET_GAME_METHOD = FUTUREGAME_PREFIX + "_get_game_method";

  public static final String GAME_GET_PLAYER_NAME = GAME_PREFIX + "_get_player_name_method";
  public static final String GAME_GET_PLAYER_IN_TURN = GAME_PREFIX + "_get_player_in_turn_method";
  public static final String GAME_MOVE = GAME_PREFIX + "_move_method";
}
```
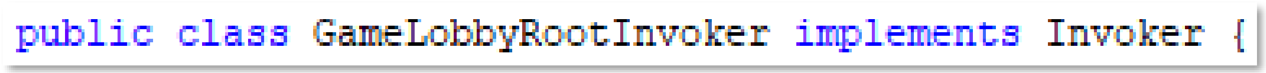
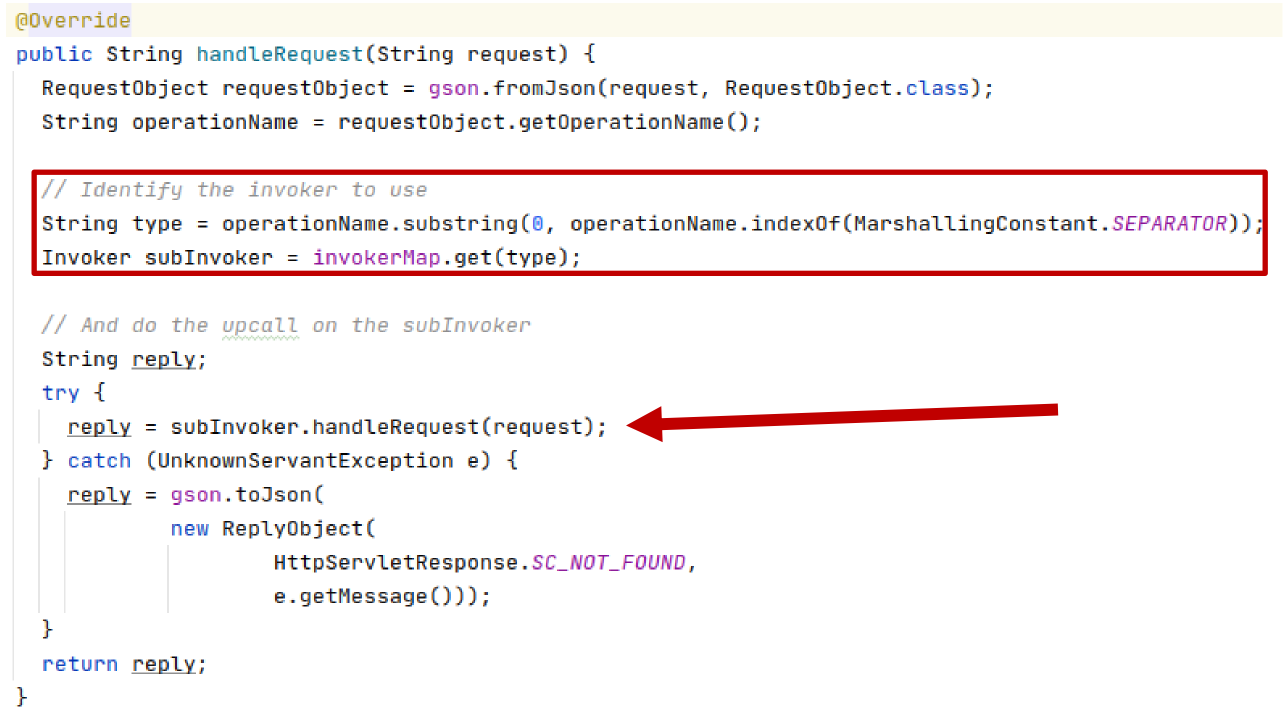

My method names includes the name of the class

So, I Delegate

- The Invoker simply looks up the associated Invoker



```java
public class GameLobbyRootInvoker implements Invoker {
```

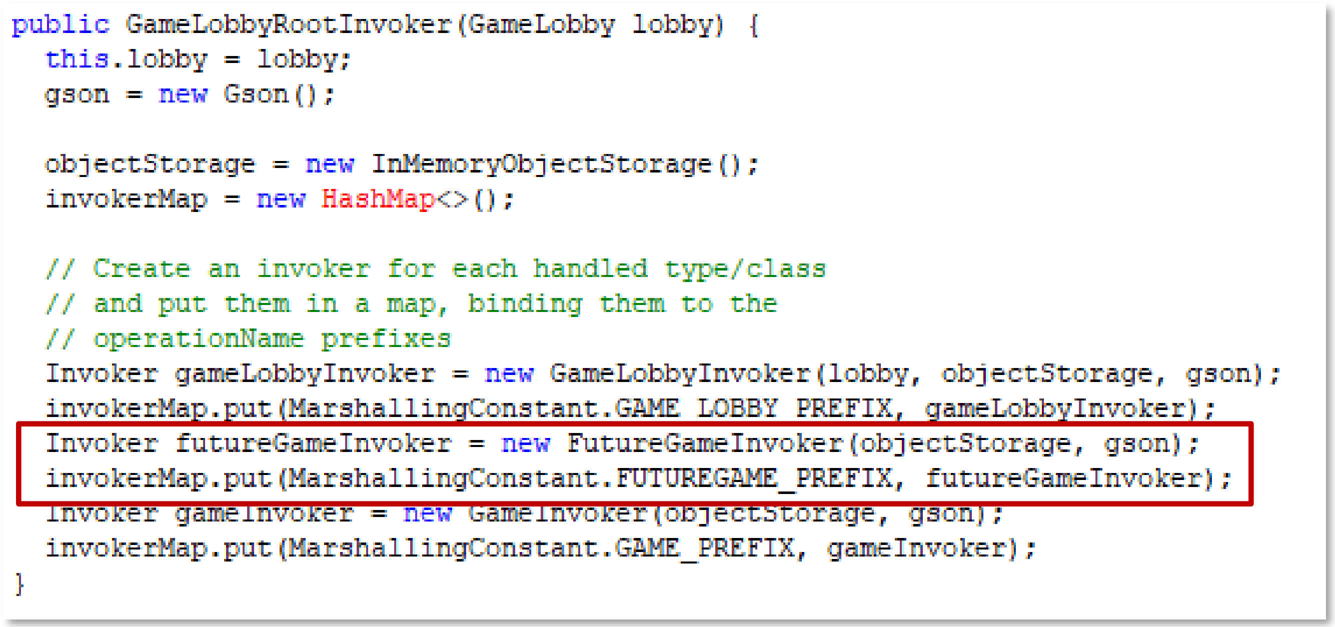


```java
@Override
public String handleRequest(String request) {
  RequestObject requestObject = gson.fromJson(request, RequestObject.class);
  String operationName = requestObject.getOperationName();

  // Identify the invoker to use
  String type = operationName.substring(0, operationName.indexOf(MarshallingConstant.SEPARATOR));
  Invoker subInvoker = invokerMap.get(type);

  // And do the upcall on the subInvoker
  String reply;
  try {
    reply = subInvoker.handleRequest(request);
  } catch (UnknownServantException e) {
    reply = gson.toJson(
            new ReplyObject(
                    HttpServletResponse.SC_NOT_FOUND,
                    e.getMessage()));
  }
  return reply;
}
```

Extract the class name

Setting up the Lookup

- Have to initialize the *root invoker*



```
public GameLobbyRootInvoker(GameLobby lobby) {
  this.lobby = lobby;
  gson = new Gson();

  objectStorage = new InMemoryObjectStorage();
  invokerMap = new HashMap<>();

  // Create an invoker for each handled type/class
  // and put them in a map, binding them to the
  // operationName prefixes
  Invoker gameLobbyInvoker = new GameLobbyInvoker(lobby, objectStorage, gson);
  invokerMap.put(MarshallingConstant.GAME_LOBBY_PREFIX, gameLobbyInvoker);
  Invoker futureGameInvoker = new FutureGameInvoker(objectStorage, gson);
  invokerMap.put(MarshallingConstant.FUTUREGAME_PREFIX, futureGameInvoker);
  Invoker gameInvoker = new GameInvoker(objectStorage, gson);
  invokerMap.put(MarshallingConstant.GAME_PREFIX, gameInvoker);
}
```

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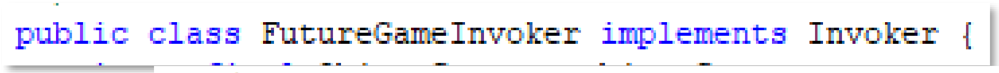
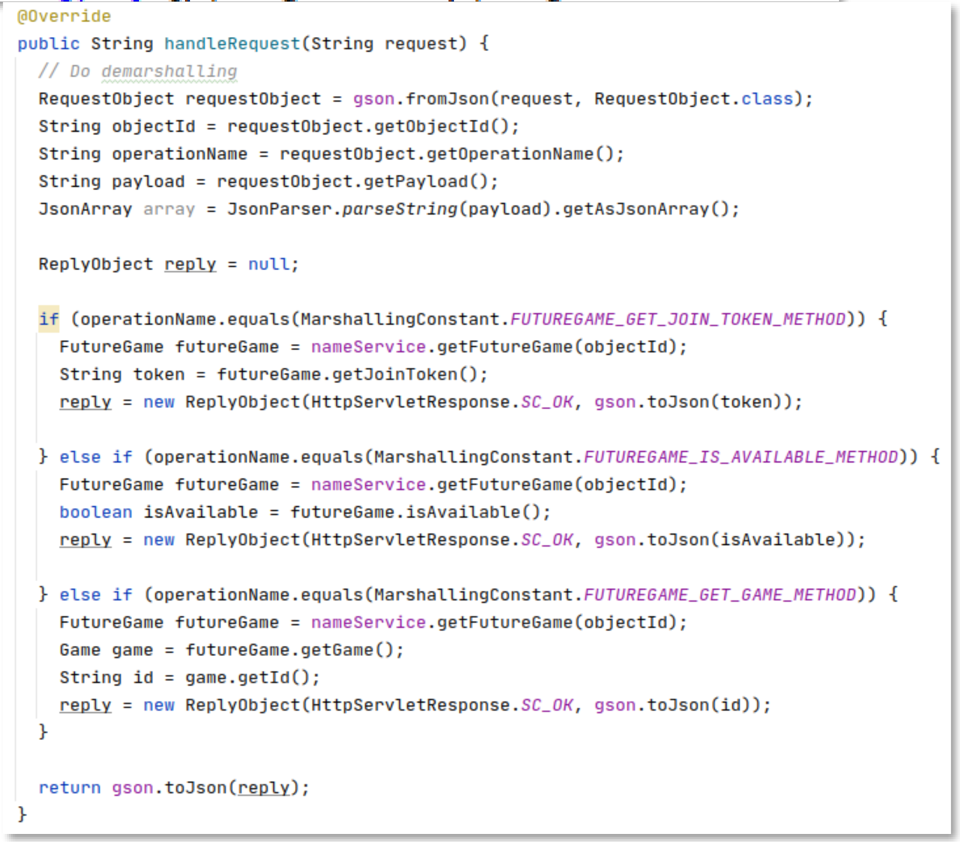
Smaller, Type-specific, Invokers

- Achieve *high cohesion* in the type specific invokers



```
public class FutureGameInvoker implements Invoker {
```



```
@Override
public String handleRequest(String request) {
  // Do demarshalling
  RequestObject requestObject = gson.fromJson(request, RequestObject.class);
  String objectId = requestObject.getObjectId();
  String operationName = requestObject.getOperationName();
  String payload = requestObject.getPayload();
  JsonArray array = JsonParser.parseString(payload).getAsJsonArray();

  ReplyObject reply = null;

  if (operationName.equals(MarshallingConstant.FUTUREGAME_GET_JOIN_TOKEN_METHOD)) {
    FutureGame futureGame = nameService.getFutureGame(objectId);
    String token = futureGame.getJoinToken();
    reply = new ReplyObject(HttpServletResponse.SC_OK, gson.toJson(token));

  } else if (operationName.equals(MarshallingConstant.FUTUREGAME_IS_AVAILABLE_METHOD)) {
    FutureGame futureGame = nameService.getFutureGame(objectId);
    boolean isAvailable = futureGame.isAvailable();
    reply = new ReplyObject(HttpServletResponse.SC_OK, gson.toJson(isAvailable));

  } else if (operationName.equals(MarshallingConstant.FUTUREGAME_GET_GAME_METHOD)) {
    FutureGame futureGame = nameService.getFutureGame(objectId);
    Game game = futureGame.getGame();
    String id = game.getId();
    reply = new ReplyObject(HttpServletResponse.SC_OK, gson.toJson(id));
  }

  return gson.toJson(reply);
}
```

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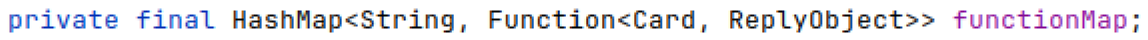
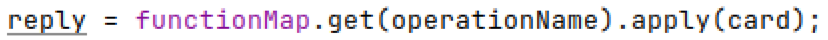
[SideBar]

- Many, very similar, methods can be *lambda'ed* a lot☺
  - In my CardInvoker, I just have a mapping from OperationName to f(card): ReplyObject



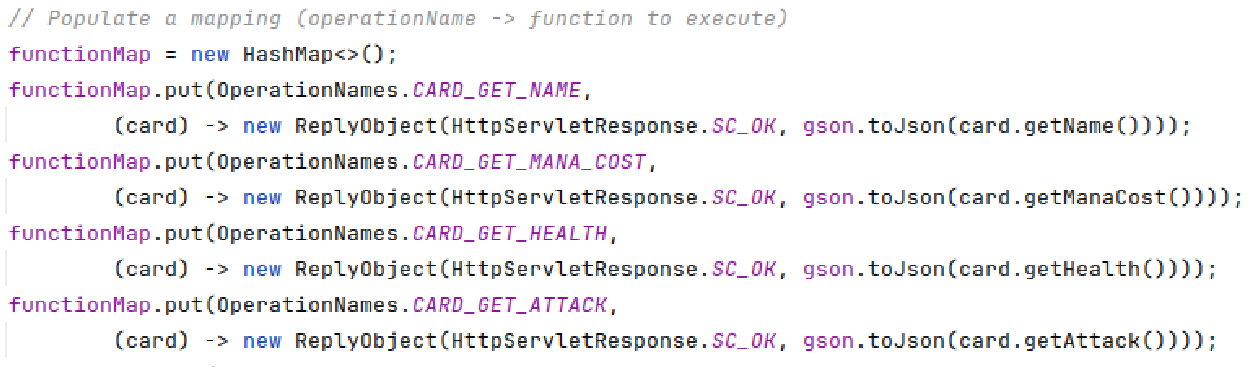
```
private final HashMap<String, Function<Card, ReplyObject>> functionMap;
```

  - In my 'handleRequest()' I do little else but just lookup and apply



```
reply = functionMap.get(operationName).apply(card);
```

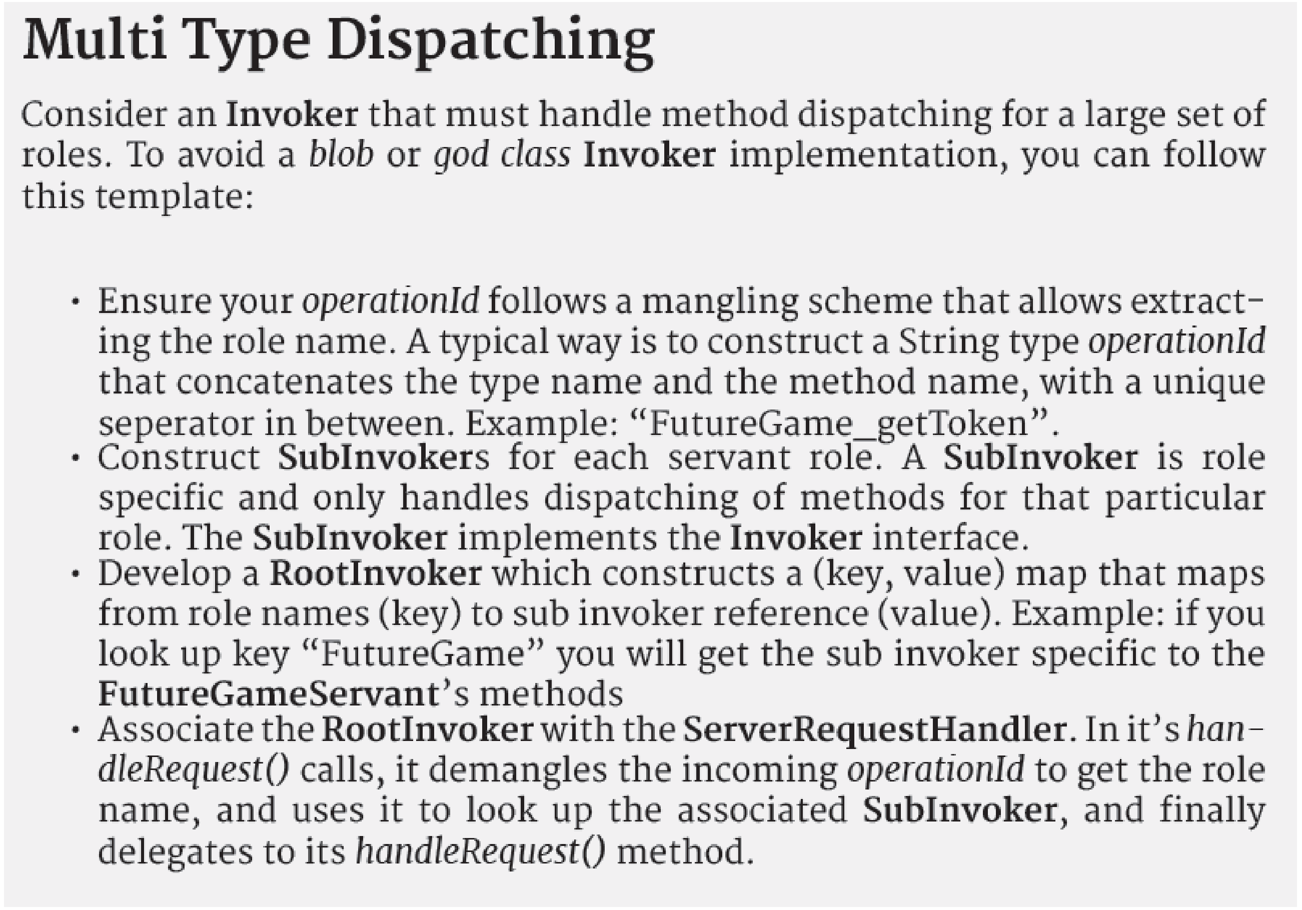
  - … on a configured function map



```
// Populate a mapping (operationName -> function to execute)
functionMap = new HashMap<>();
functionMap.put(OperationNames.CARD_GET_NAME,
        (card) -> new ReplyObject(HttpServletResponse.SC_OK, gson.toJson(card.getName())));
functionMap.put(OperationNames.CARD_GET_MANA_COST,
        (card) -> new ReplyObject(HttpServletResponse.SC_OK, gson.toJson(card.getManaCost())));
functionMap.put(OperationNames.CARD_GET_HEALTH,
        (card) -> new ReplyObject(HttpServletResponse.SC_OK, gson.toJson(card.getHealth())));
functionMap.put(OperationNames.CARD_GET_ATTACK,
        (card) -> new ReplyObject(HttpServletResponse.SC_OK, gson.toJson(card.getAttack())));
```

Process

- Conclusion:



Multi Type Dispatching

Consider an **Invoker** that must handle method dispatching for a large set of roles. To avoid a *blob* or *god class* **Invoker** implementation, you can follow this template:

- Ensure your *operationId* follows a mangling scheme that allows extracting the role name. A typical way is to construct a String type *operationId* that concatenates the type name and the method name, with a unique seperator in between. Example: "FutureGame_getToken".
- Construct **SubInvoker**s for each servant role. A **SubInvoker** is role specific and only handles dispatching of methods for that particular role. The **SubInvoker** implements the **Invoker** interface.
- Develop a **RootInvoker** which constructs a (key, value) map that maps from role names (key) to sub invoker reference (value). Example: if you look up key "FutureGame" you will get the sub invoker specific to the **FutureGameServant**'s methods
- Associate the **RootInvoker** with the **ServerRequestHandler**. In it's *handleRequest()* calls, it demangles the incoming *operationId* to get the role name, and uses it to look up the associated **SubInvoker**, and finally delegates to its *handleRequest()* method.