Your systems. Working as one.

Data-centric Invocable Services

Workshop on Real-Time, Embedded and Enterprise-Scale Time-Critical Systems

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Data-Centricity by Example: Calendaring

Imperative Process:

1. Email: “Meet Monday at 10:00.”
2. Email: “Meeting moved to Tuesday.”
3. Email: “Here’s conference call info…”

4. You: “Where do I have to be? When?”
5. You: (*sifting through email…*)

Data-Centricity by Example: Calendaring

Data-centric Process:

1. Calendar: (*add meeting Monday at 10:00*)
2. Calendar: (*move meeting to Tuesday*)
3. Calendar: (*add dial-in info*)

4. You: “Where do I have to be? When?”
5. You: (*check calendar*)

Data-centric vs. Imperative Styles

- **Imperative**
  - Tell someone to do something
  - Check whether they did it
- **Data-centric**

Functions coupled; State implicit

Functions decoupled; State explicit

Canonical	SQL	HTTP	DDS
Create	INSERT	POST	write
Read	SELECT	GET	read
Update	UPDATE	PUT	write
Delete	DELETE	DELETE	dispose
on_event	TRIGGER	—	on_data_ available

Conflict?

- **Data-centricity benefits system designers**
  - (Eventually) Consistent “truth”
  - Scalability and elasticity, because of stateless logic
  - Evolvability, because of functional decoupling
  - Robustness to communication failures
- **Programmers think imperatively**

```
try {
  doSomethingThatMayFail();
  doSomethingOnSuccess();
} catch (FailureOccurred) {
  doSomethingElseOnFailure();
}
```

Conflict?

Are these models fundamentally in conflict?

***No*.**

Reconciliation

"Dude, instructions are just data."

— John Von Neumann, 1945

- *Desires* are also just data
- *Objectives* are also just data

Best practice: Don't tell someone to do something; assert your desired future state

Reconciliation

Imperative View

```
try {
   doSomething();
   doOnSuccess();
} catch (Failure) {
   doOnFailure();
}
```

Data-centric View

```
struct ThingDesired {
   string thingWanted;
}

struct ThingHappened {
   string thingWanted;
   boolean success;
};

…
```

Reconciliation

Imperative View

```
try {
   doSomething();
   doOnSuccess();
} catch (Failure) {
   doOnFailure();
}
```

Data-centric View

```
…
create(
    thingWanted = “something”)
on_event(
    thingWanted == “something”
    &&
    success == true) {
   update(
    thingWanted = “onSuccess”)
}
on_event(
    thingWanted == “something”
    &&
    success == false) {
   update(
    thingWanted = “onFailure”)
}
```

Reconciliation

Imperative View

This way is easier

…to write the first time

…to understand top-down, sequentially

Data-centric View

This way is easier

…to scale out

…to extend

…to maintain incrementally

…to understand bottom-up, causally

Reconciliation

Imperative View

Data-centric View

Express application code this way

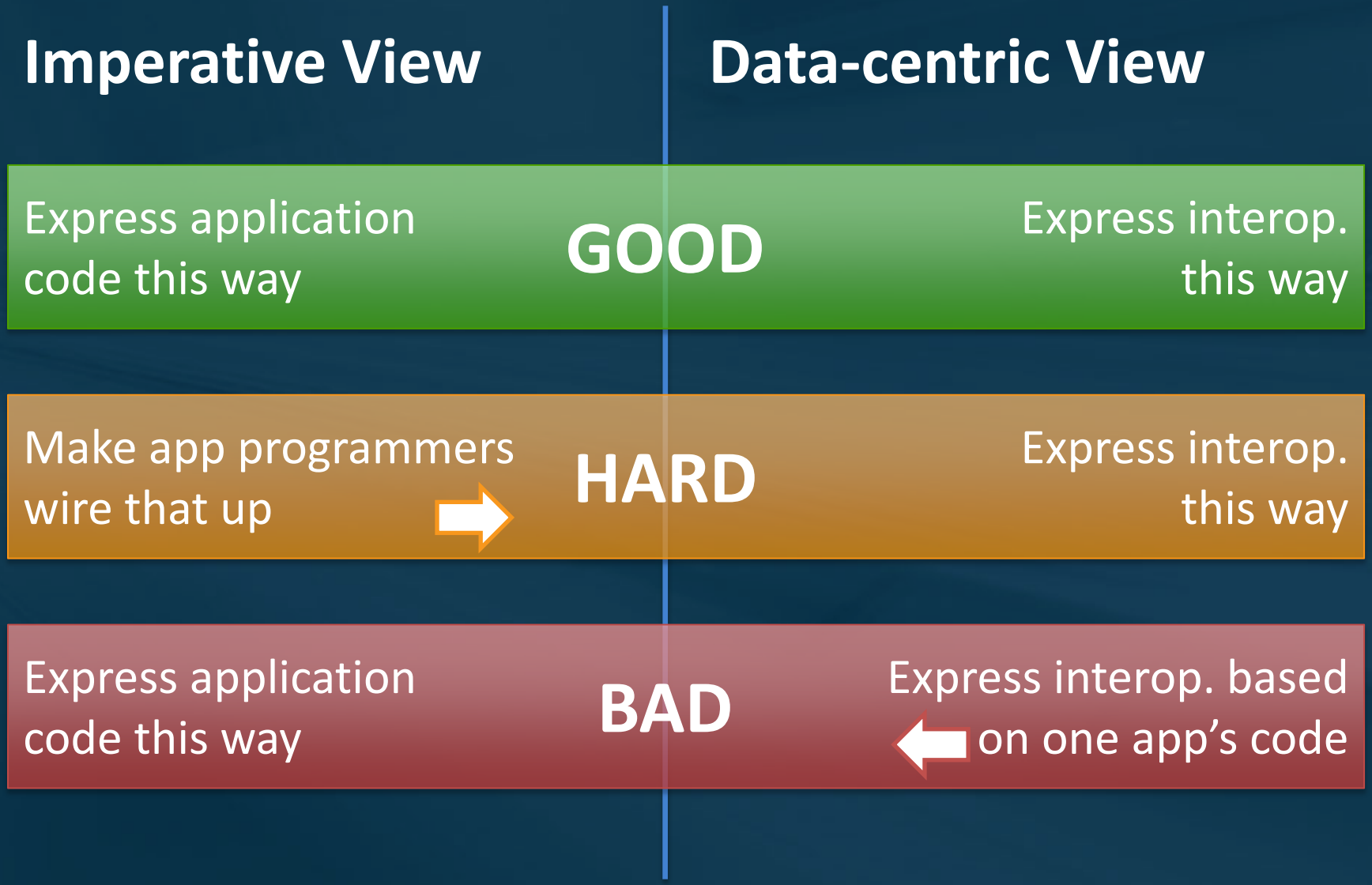
GOOD

Express interop. this way

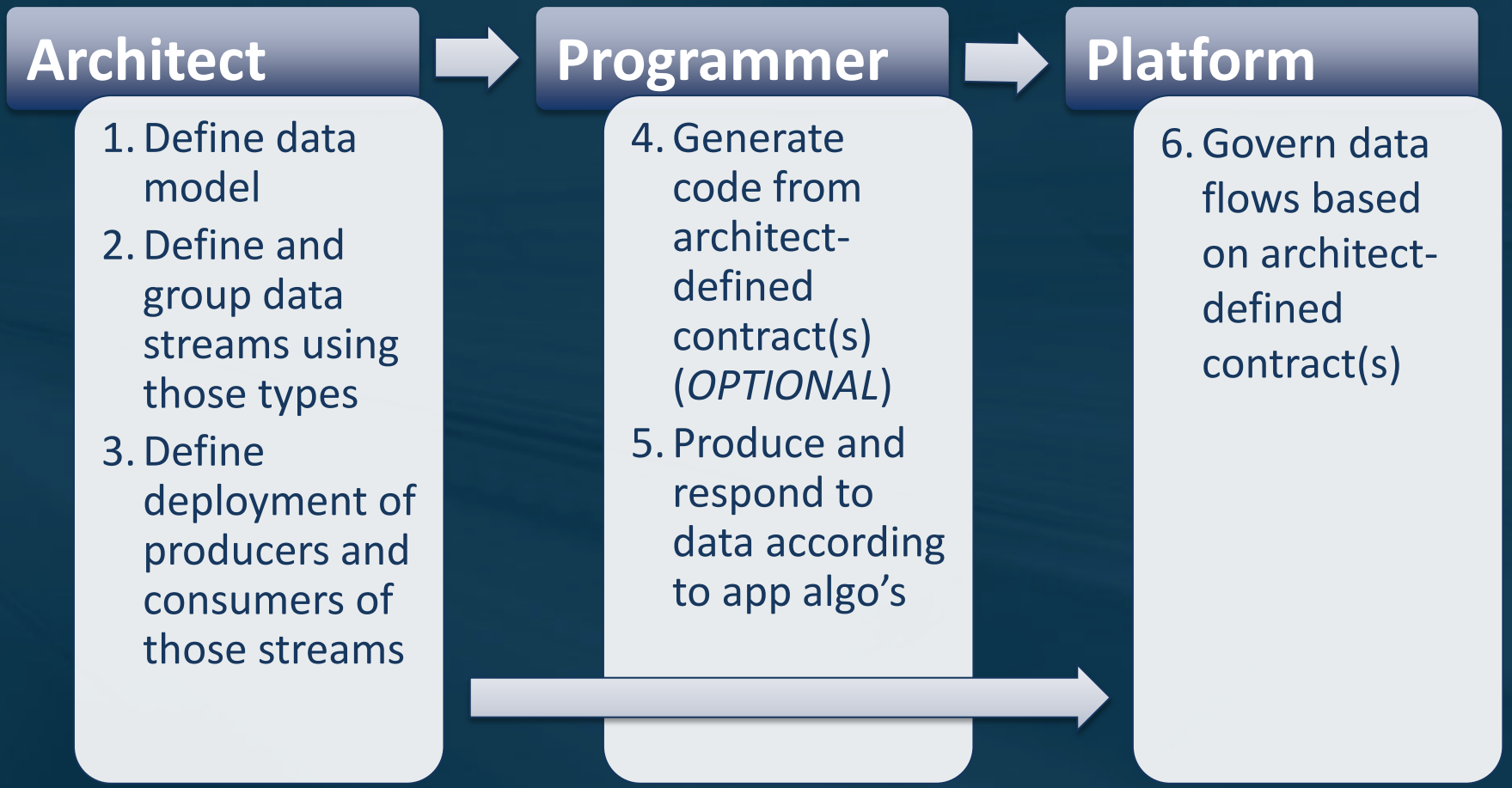
This is what we mean by "data-centric invocable service":

- Request looks like explicit "call" (RMI or similar)
- Interoperability on the basis of data, not functional implementation
- *Caller and Callee may use different programming models*

Reconciliation

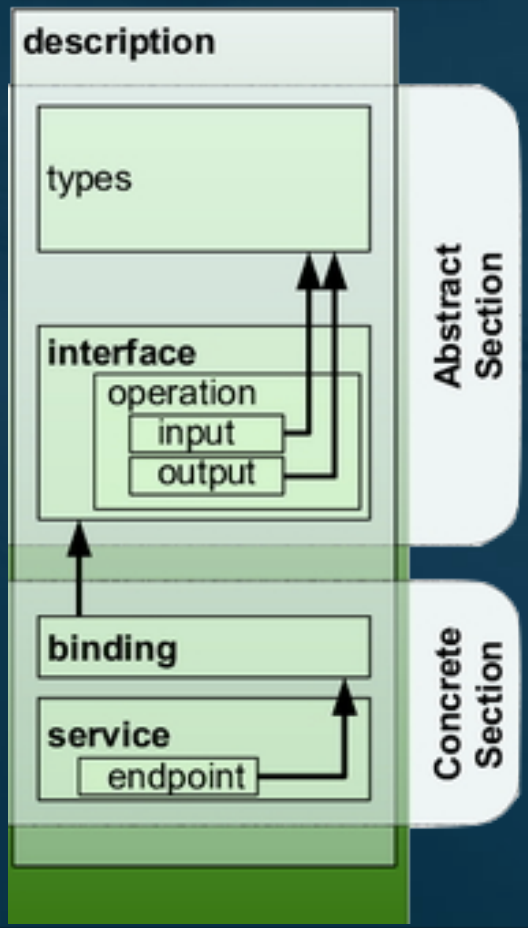


Process



Process Example: WSDL

Architect → **Programmer**




```
class MyService {
  Result1 doThis(
    Args1) {
    …
  }

  Result2 doThat(
    Args2) {
    …
  }
  …
}
```

Standard WSDL bindings exist for SOAP, REST, and SMTP.

Additional bindings could be defined for DDS or other technologies.

Figure courtesy of ICONIX, http://www.iconixsw.com/Articles/SOARoadmap.html

Hypothetical DDS IDL Example

```
struct Foo {
  @Key long id;
  long x;
  double y;
};

struct Bar {
  @Key string who;
  short baz;
};
```

```
local interface Svc {
  @InTopic("FooTpc")
  @OutTopic("BarTpc")
  Bar doFoo(in Foo f);
};
```

Control binding to topics for easy subscription, filtering, and QoS control

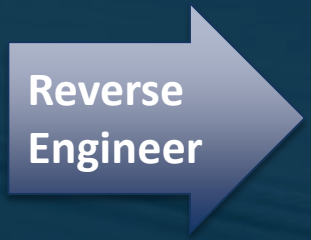
Hypothetical DDS IDL Example

```
struct Foo {
  @Key long id;
  long x;
  double y;
};

struct Bar {
  @Key string who;
  short baz;
};
```

```
local interface Svc {
  @InTopic(
     value="T1”,
     key="42")
  @OutTopic(
     value="T2",
     key="me")
  Bar doFoo1(in Foo f);

  @InTopic(
     value="T1”,
     key="29")
  @OutTopic(
     value="T2",
     key="you")
  Bar doFoo2(in Foo f);
};
```

Hypothetical DDS IDL Counter-Example

```
local interface Svc {
  Foo doFoo(
    out string x,
    inout long y,
    in double z);
  Bar doBar(
    in long a,
    out float b,
    inout short c);
};
```




```
union Svc_Type
switch (WhichOpEnum){
case Svc_doFoo_CALL:
  Svc_doFoo_InStruct
    sdfis;
case Svc_doFoo_RETURN:
  Svc_doFoo_OutStruct
    sdfos;
case Svc_doBar_CALL:
  Svc_doBar_InStruct
    sdbis;
case Svc_doBar_RETURN:
  Svc_doBar_OutStruct
    sdbos;
};
```

Why is This Gross?

- Insane data type to make a DBA cringe in horror
- Segregates data model: human-written vs. machine-generated
- (Someone's) API constraints baked into shared interop. interface
- Heavily influenced by scalability assumptions …which may or may not be valid
- Over-reliance on complex filtering on subscriber side
- Fine-grained QoS governance almost impossible

```
union Svc_Type
switch (WhichOpEnum){
case Svc_doFoo_CALL:
  Svc_doFoo_InStruct
    sdfis;
case Svc_doFoo_RETURN:
  Svc_doFoo_OutStruct
    sdfos;
case Svc_doBar_CALL:
  Svc_doBar_InStruct
    sdbis;
case Svc_doBar_RETURN:
  Svc_doBar_OutStruct
    sdbos;
};
```

Summary

- Data-centricity remains an architectural best practice
  - Many of its benefits accrue at the systems level
- App programmers may be more comfortable with higher-level API
- These two sets of benefits are not exclusive
  - Design system interop. interface
  - Design programming interface
  - Bind them together
- Proven examples exist:
  - Architecture
  - Workflow
  - Data and service description
  - Programming model