Pragmatic Type Interoperability

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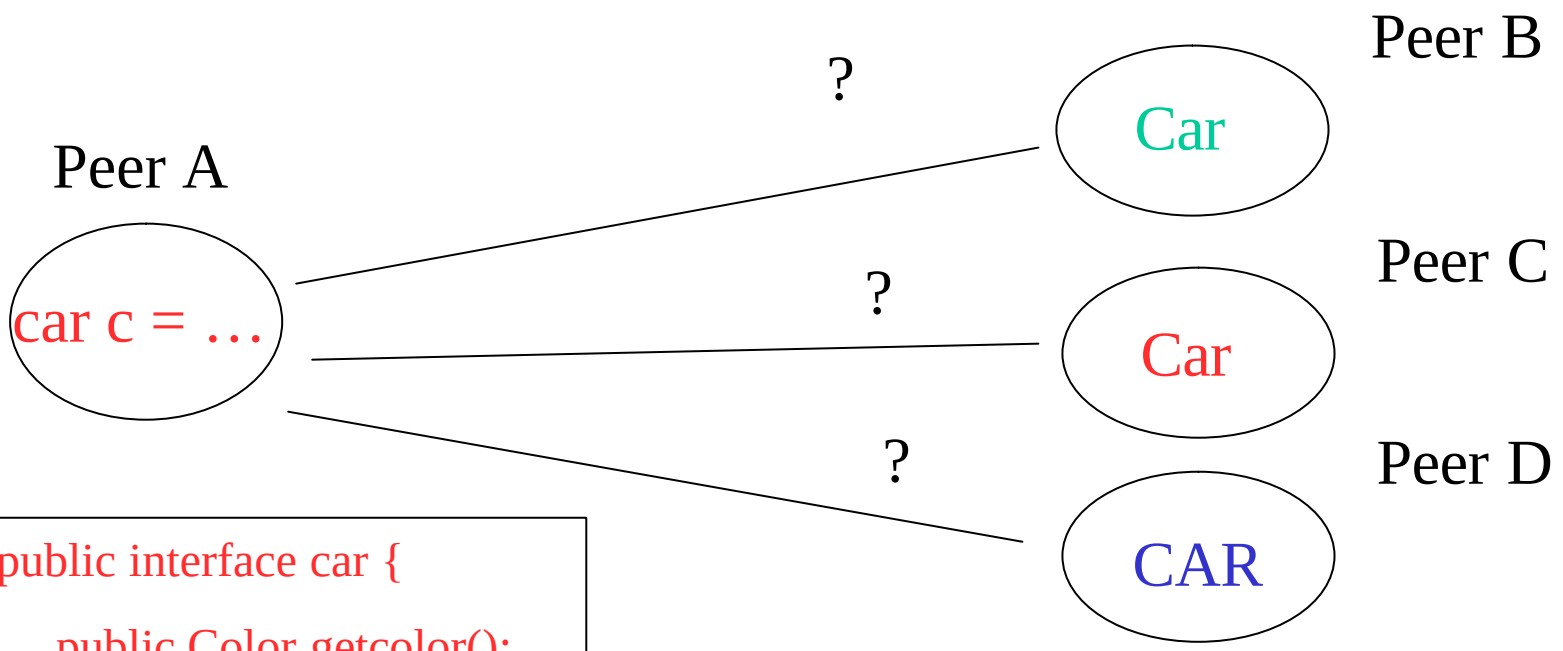
Roadmap

- Context & motivation
- Faces of interoperability
- Object passing semantics & seminal work
- Simplified protocol & implementation issues
- Overhead
- Conclusions & future work

Context & Motivation

- Middleware for peer-to-peer (p2p) object sharing
  - *Borrow/lend* (BL) abstraction, publish/subscribe variant
- Type safety
  - Ideally static within component/processes
- Scalability
  - Abstraction, algorithms
- Interoperability

Illustration

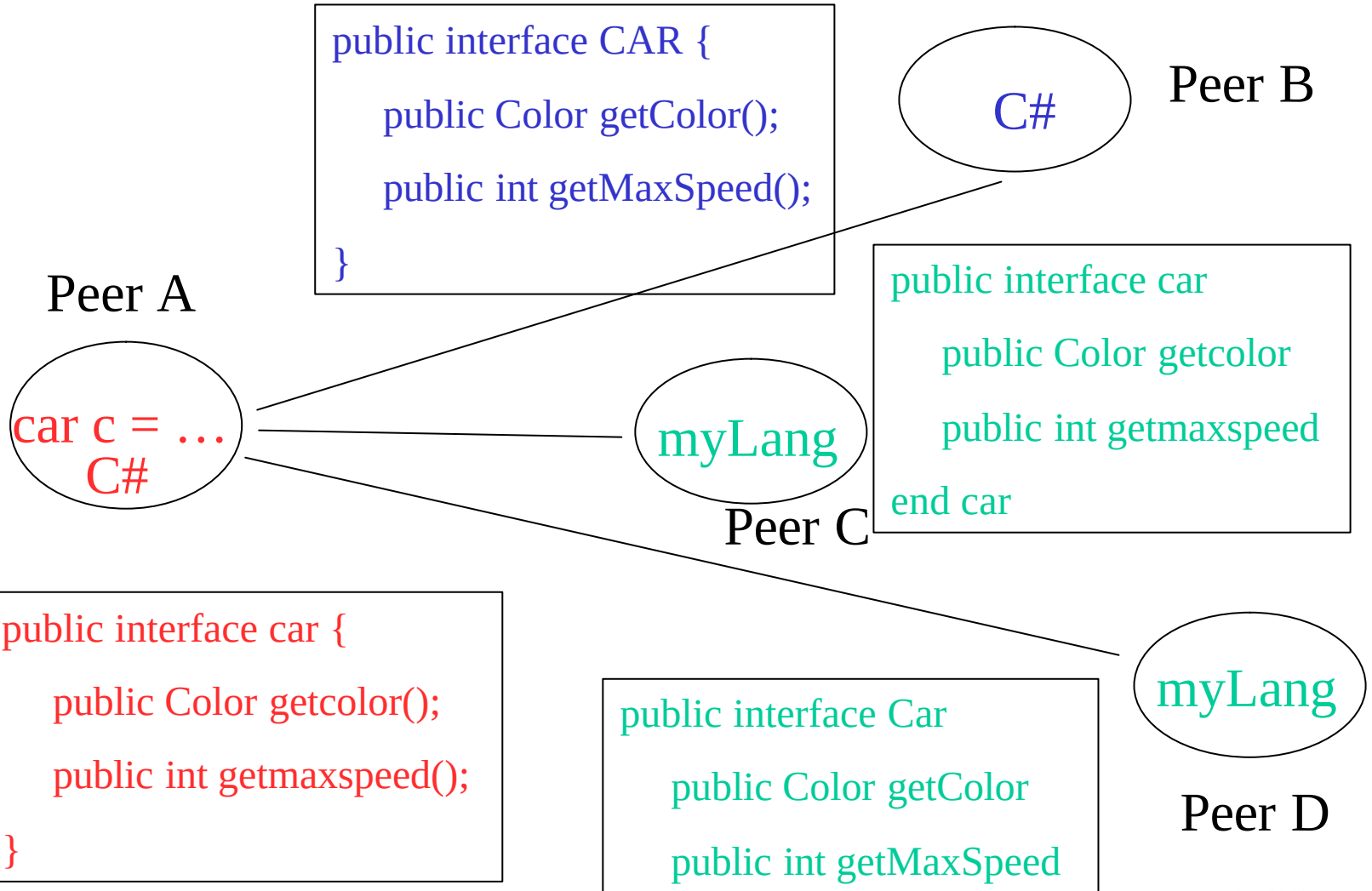



```
public interface car {
    public Color getcolor();
    public int getmaxspeed();
}
```

Interoperability

- LI: “language interoperability”
  - Same type, different languages
  - Usually explicit agreement
- CI: “component interoperability”
  - Similar type, same language
  - cf. *implicit, structural conformance*
    - Single language centralized settings
- LI & CI
  - Similar type, potentially different languages

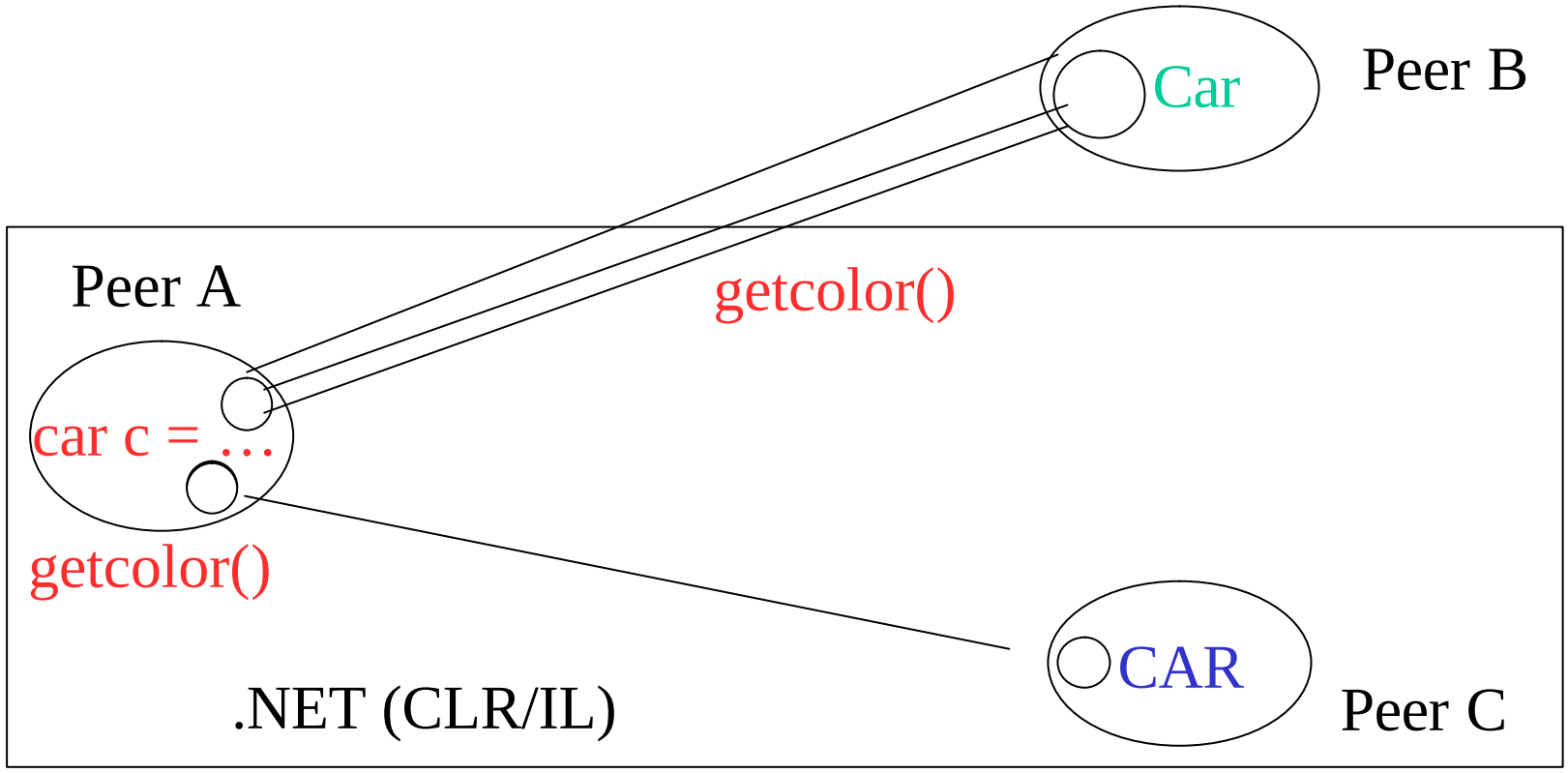
Illustration



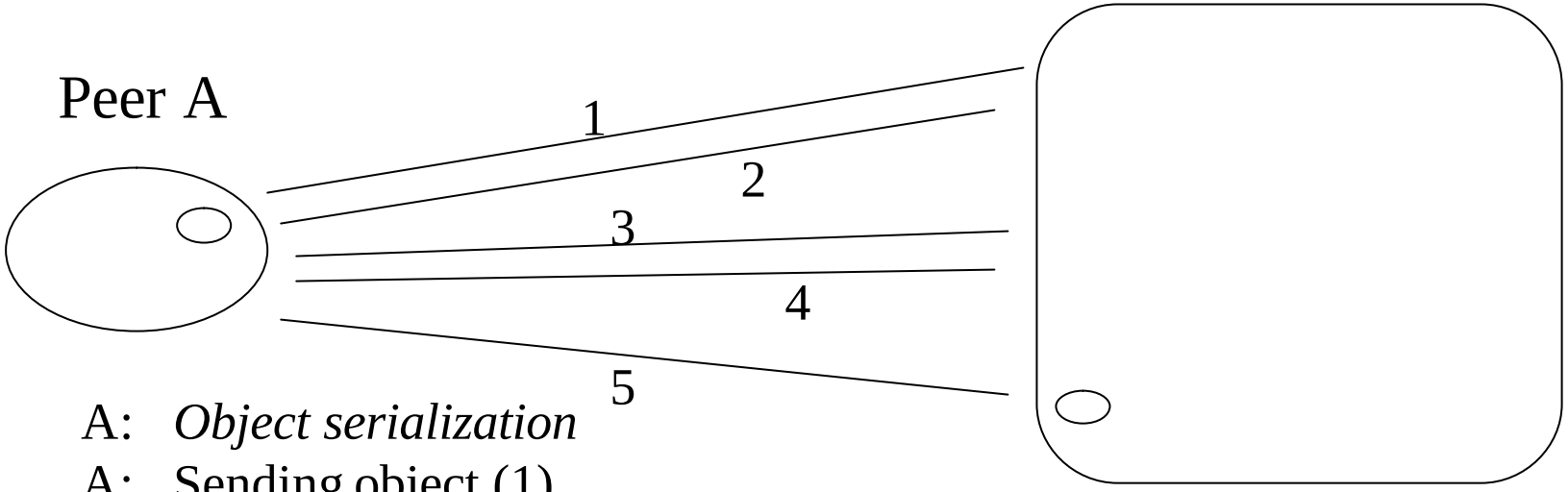
Semantics & Seminal Work

- RS: pass-by-reference semantics
  - Objects invoked remotely (RPC et al.)
  - Proxies and instances of primitive types “transferred”
  - CORBA / .NET (LI), Renaissance [Muckelbauer&Russo] (LI&CI)
- VS: pass-by-value semantics
  - Objects are transferred
  - CORBA (LI limited), .NET (LI)

Illustration



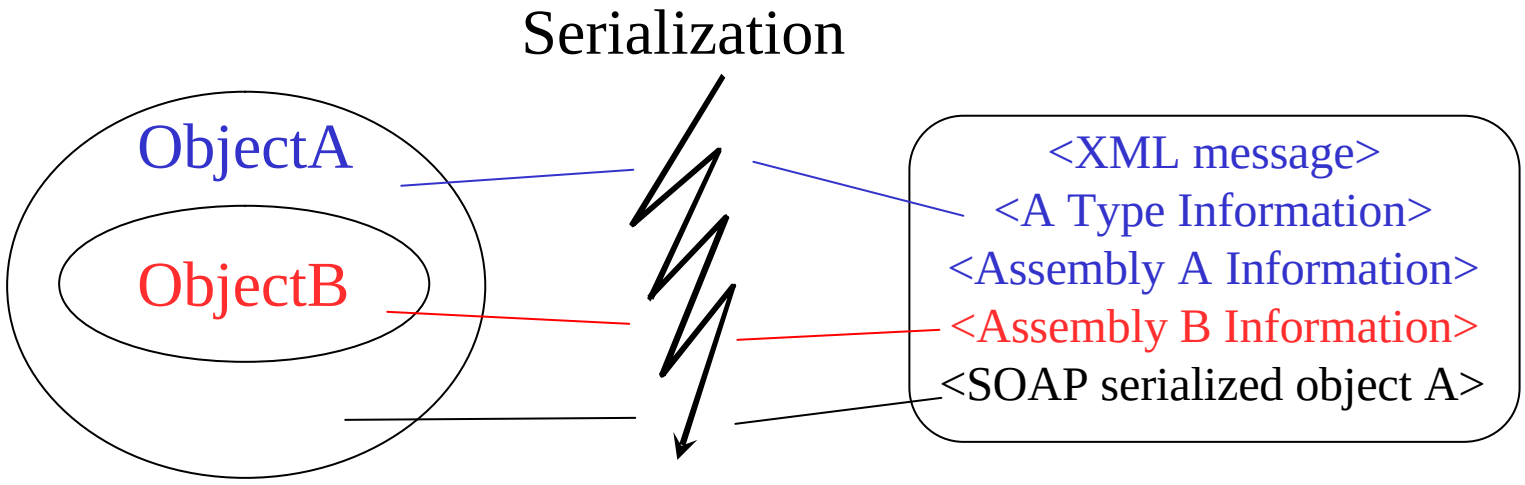
Simple Protocol & Issues (VS)



A: *Object serialization*
A: Sending object (1)
B: Type lookup
B: Asking for new type information (2)
A: Sending *type representation* (3)
B: Applying *type conformance rules*
B: Asking for code, i.e., IL assembly (4)
A: Sending code (5)
B: Object deserialization
B: *Object access*

Object Serialization

- Own XML for *description* of object (type T)
  - Built-in XML serialization only for public fields
  - Binary/SOAP require T at deserialization
- SOAP for object *representation*



Type Representation

- XML serialization with own introspection types
  - Introspection to learn about a type T, but
  - Instances of built-in introspection types (fields, methods, etc.) require type T on target peer

```
public interface CAR {
    public Color getColor();
    public int getMaxSpeed();
}
```

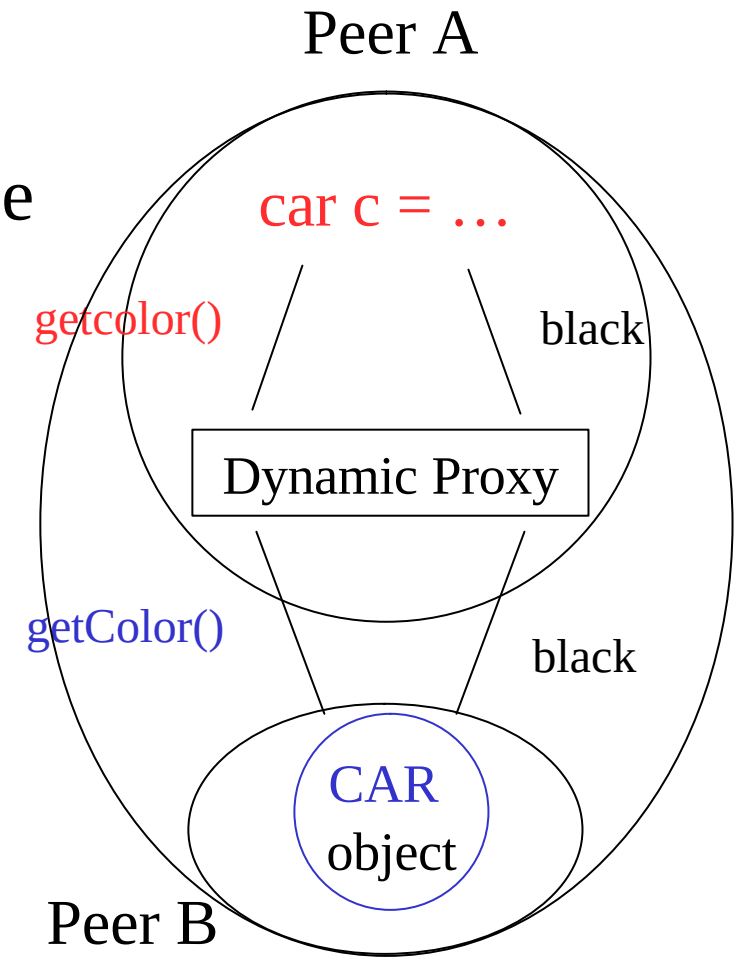
```
<XML message>
<TypeDescription
<classes> <classInfo name="CAR"/></classes>
 <superClasses></superClasses>
 <fields></fields>
 <methods>
        <methodInfo name="getMaxSpeed"
          modifier="public" returnType="int"/>
        …
 </methods>
 <constructors></constructors>
</TypeDescription>
```

Conformance Rules (Informal)

- T conforms to T' explicitly or implicitly
- T implicitly conforms to T' iff
  - Every method in T' (supertypes) finds a method in T (supertypes):
    - Same name (case-insensitive)
    - Parameter types (same order) conform explicitly or implicitly
  - Every field in T' (st) finds a field in T (st):
    - Same name (case-insensitive)
    - Field types conform explicitly or implicitly
- Default (no-argument) constructors

Object Access

- Dynamic proxies
  - Pass-by-reference
  - Pass-by-value



Overhead

Simple types (no recursion)

- Object serialization:
  - Serialization: 16.68 [ms]
  - Deserialization: 1.32 [ms]
- Type representation:
  - Creation and serialization: 6.14 [ms]
  - Deserialization: 2.34 [ms]
- Conformance rules application: 12.66 [ms]
- Object access:
  - Direct invocation: 0.0000142 [ms]
  - Indirect invocation (dynamic proxy): 0.03 [ms]

Conclusions & Future Work

- .NET provides many useful mechanisms
  - Ready-to-use for many scenarios in LI (RS & VS)
  - More effort for achieving CI as not declared goal
  - Reflection costly, need “deeper” integration
- Using conformance (“subtyping”) relationships
  - Object routing
  - Membership management
- Variations on “type conformance”
  - More precise/flexible rules
  - Behavioral conformance for avoiding accidental conformance

Questions and Answers