A Technical Reference Architecture for the National Forest Information System

INFORMATION FRAMEWORK FOR REPORTING ON SUSTAINABLE FOREST MANAGEMENT

Presentation Overview

- NFIS Vision
- NFIS Requirements Summary
- What is a Service-based Architecture
- NFIS Reference Architecture
- C4ISR Architecture Framework
- NFIS Operational Architecture
- NFIS Technical Architecture
- NFIS System Architecture & Implementation Issues
- Technical References and Resources
- Glossary of Terms

NFIS Vision

- A single authoritative source for information on the sustainable management of forested lands.
- An infrastructure, linking service providers and service consumers interested in sustainable forest management at all levels of Canadian society.
- An integrated, extensible, national, service-based architecture providing secure access to data and services for sustainable management of forested lands.

Review of Requirements

- **NFIS provides services TO NFIS users**. NFIS users include members of provincial, territorial, federal and municipal agencies, private sector companies, NGO's and members of the general public concerned with the sustainable management of forested lands.
- **NFIS Services are provided BY NFIS participants**. Participants include members of provincial, territorial, federal and municipal agencies, private sector companies, NGO's and members of the public.
- **NFIS Services are jurisdiction neutral** but must be able to maintain and display data or service branding where required.

Review of Requirements

- **NFIS Services are provided as "close to the source" as possible**, meaning that most NFIS Services (including data) will be provided by provincial or other agencies. The NFIS project office will provide integration capabilities and some national services as required for performance or other reasons.
- **NFIS is within the Canadian Geo-spatial Data Infrastructure**. It is that component of CGDI that is directed at the sustainable management of forested lands. NFIS thus builds on general services available within CGDI.
- **NFIS services available to by non-NFIS users within the CGDI.** This will include in particular members of the Canadian and international environmental communities.
- **NFIS is a vehicle for Government On Line (GOL).**

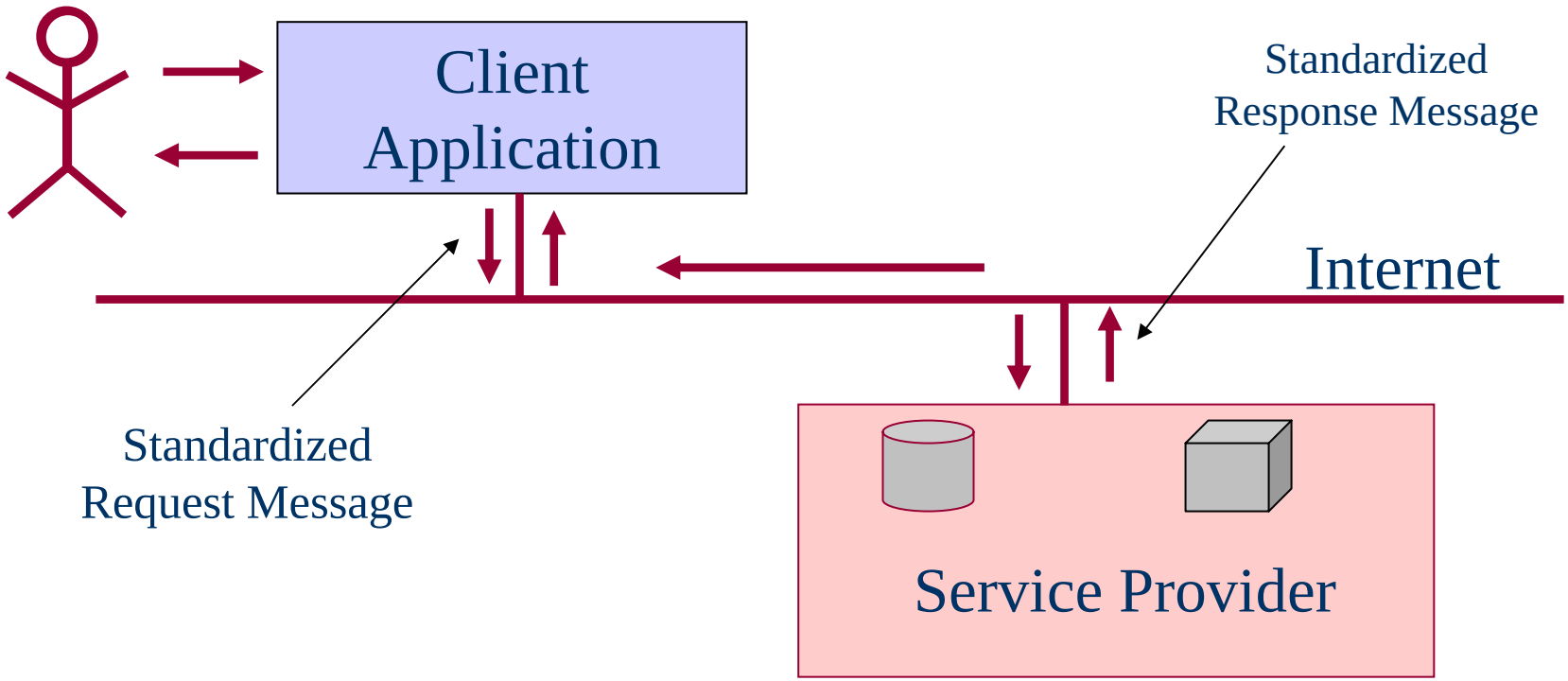
Review of Requirements

- **NFIS Service Access is non-intrusive.** NFIS Service providers must be able to continue to provide normal (non-NFIS) access to their services and data while supporting NFIS interfaces for NFIS-based users..
- **The NFIS Project Office will provide one or more national services for service discovery and these will be integrated within the CGDI.**
- **NFIS system security will rely on the security provisions of the participating service providers** and will not override them in any way.
- **NFIS will support both of Canada's official languages**. Discovery, access to and invocation of services are to be available in both English and French.

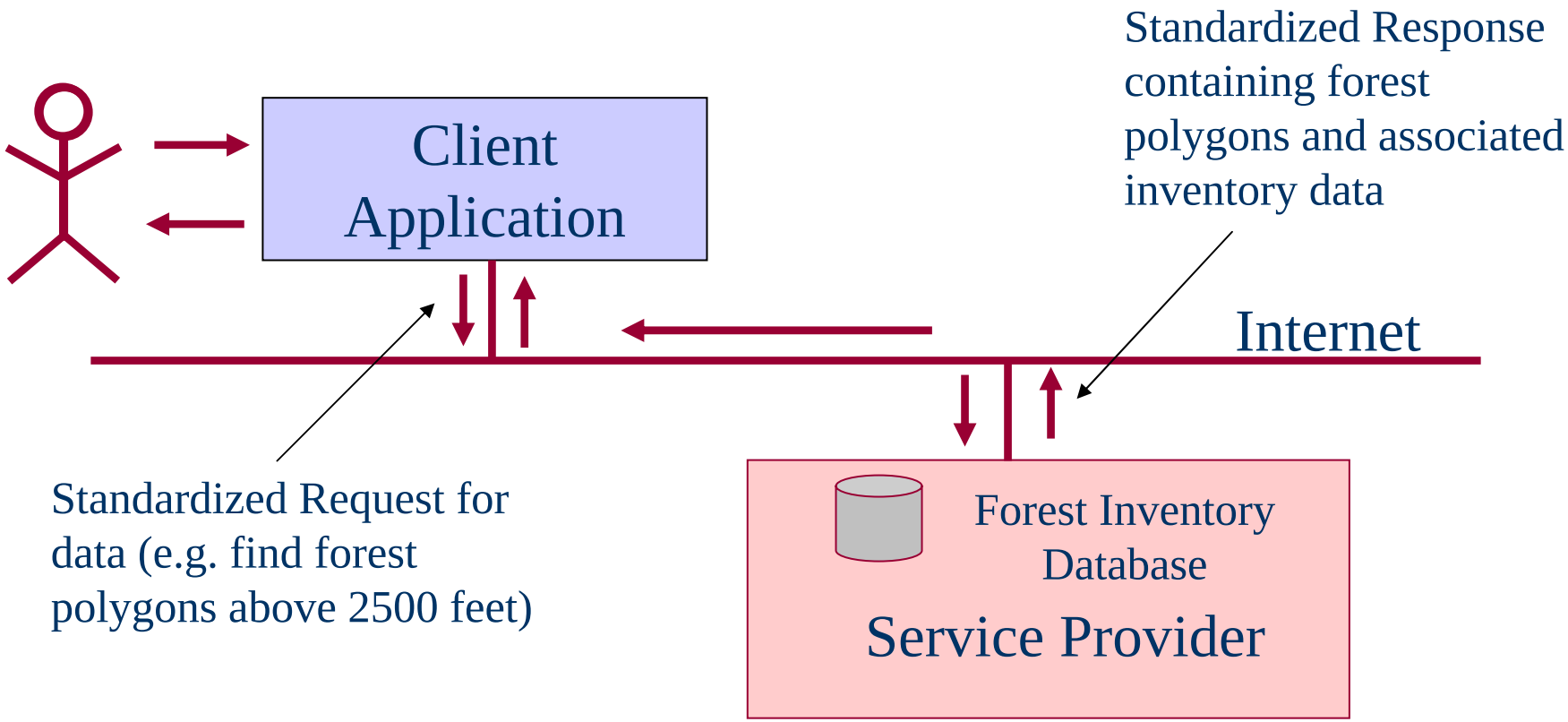
What is a Service-Based Architecture?

- All functionality and data are accessible through services over the Internet.
- A service is a contract between a client application, connected to a person, and a server.
- A service involves sending a standardized message to the service provider and getting a response in a standardized form.
- A request may be for data or for some kind of data processing.

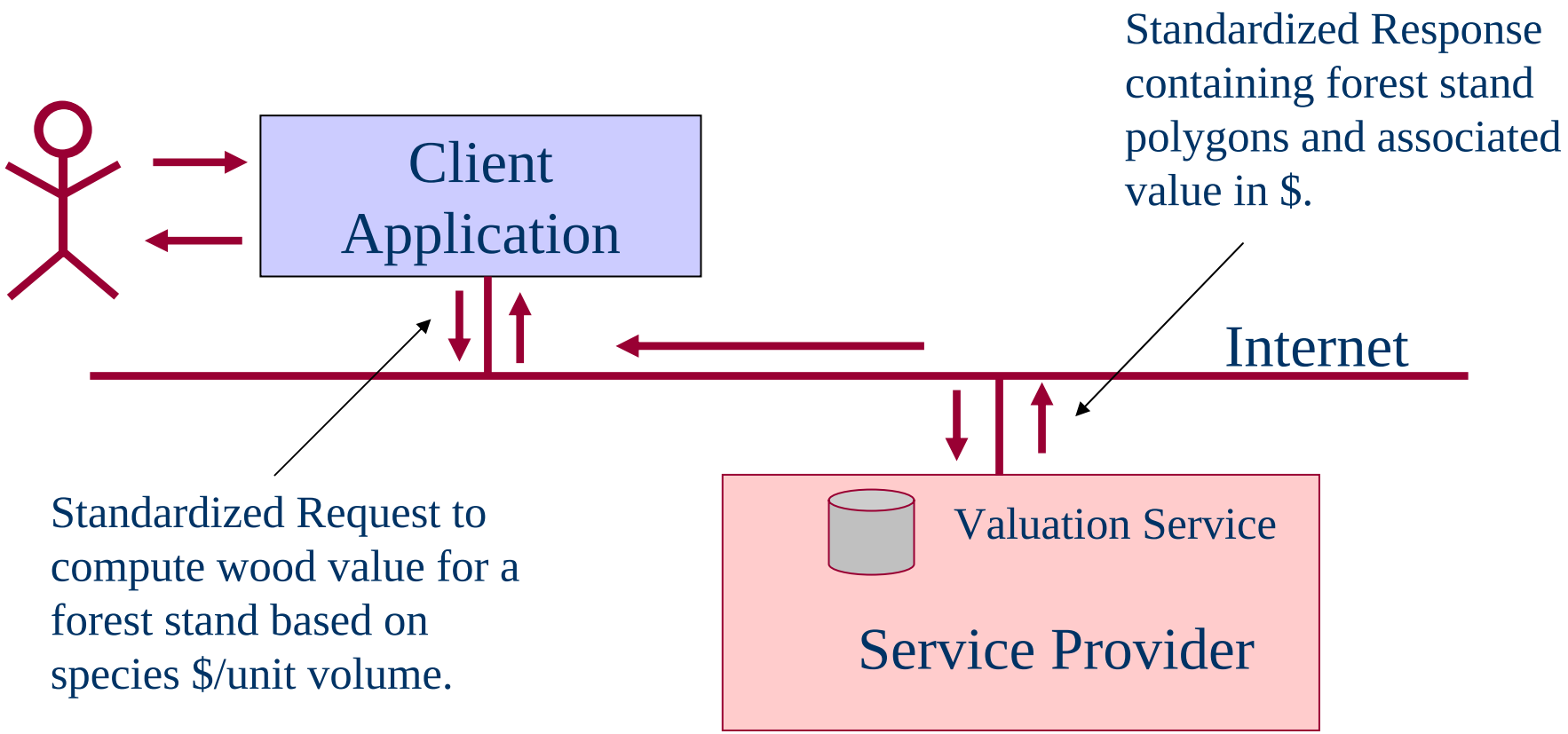
What is a Service-Based Architecture?



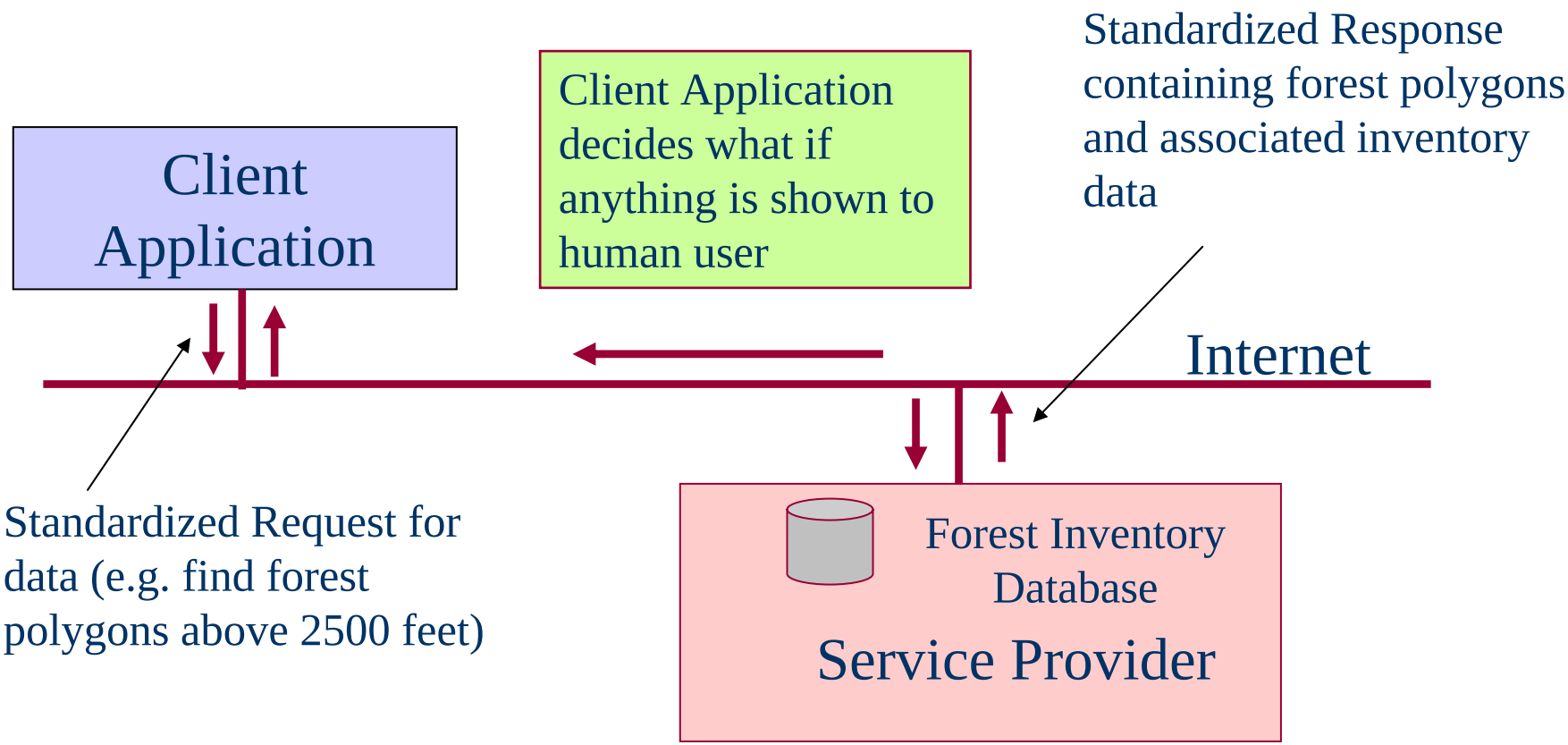
Services can provide data access !



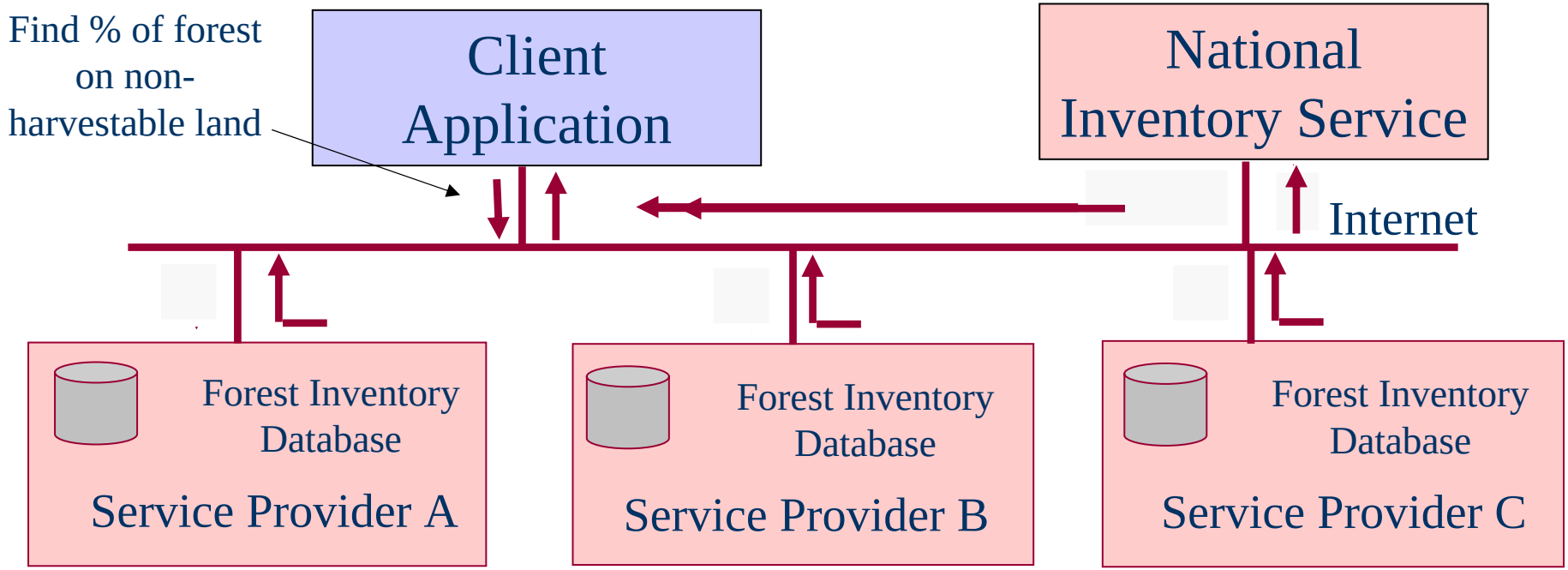
Services can do data processing !



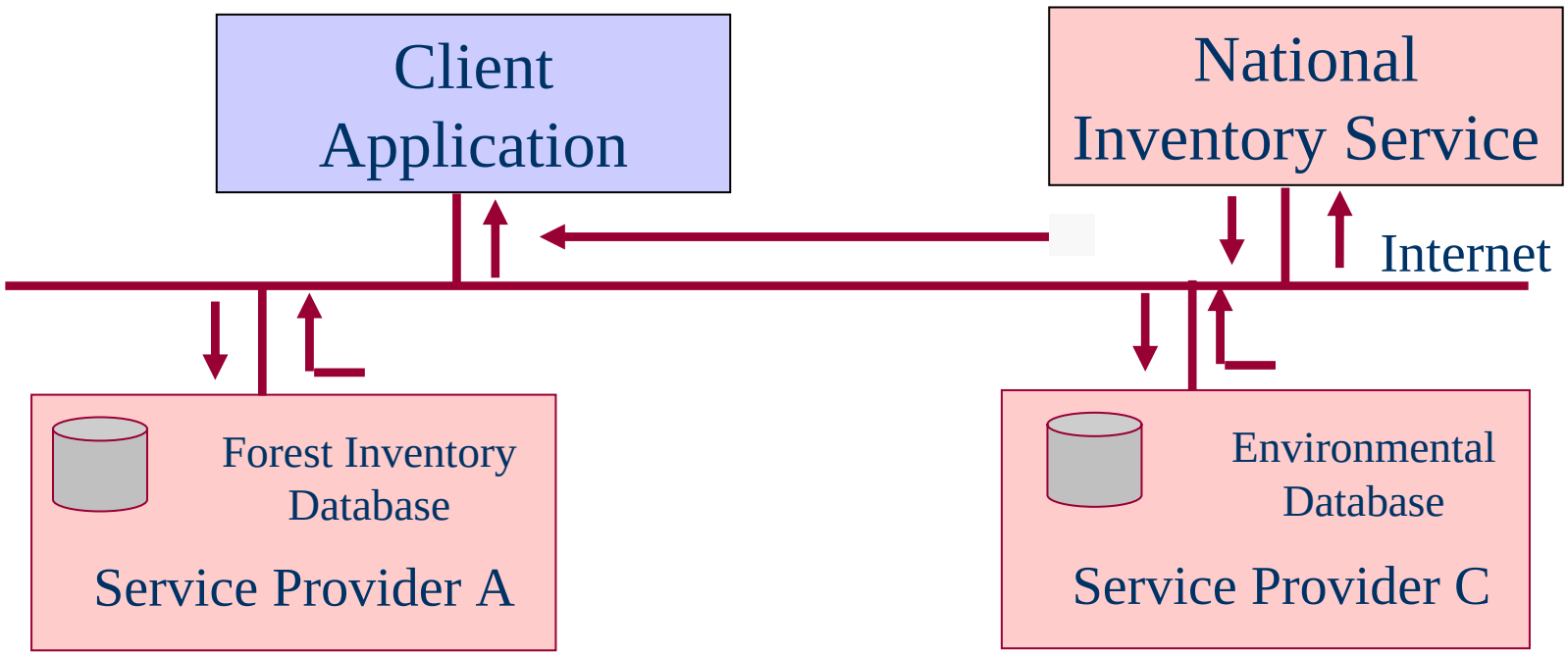
Services can be invisible !



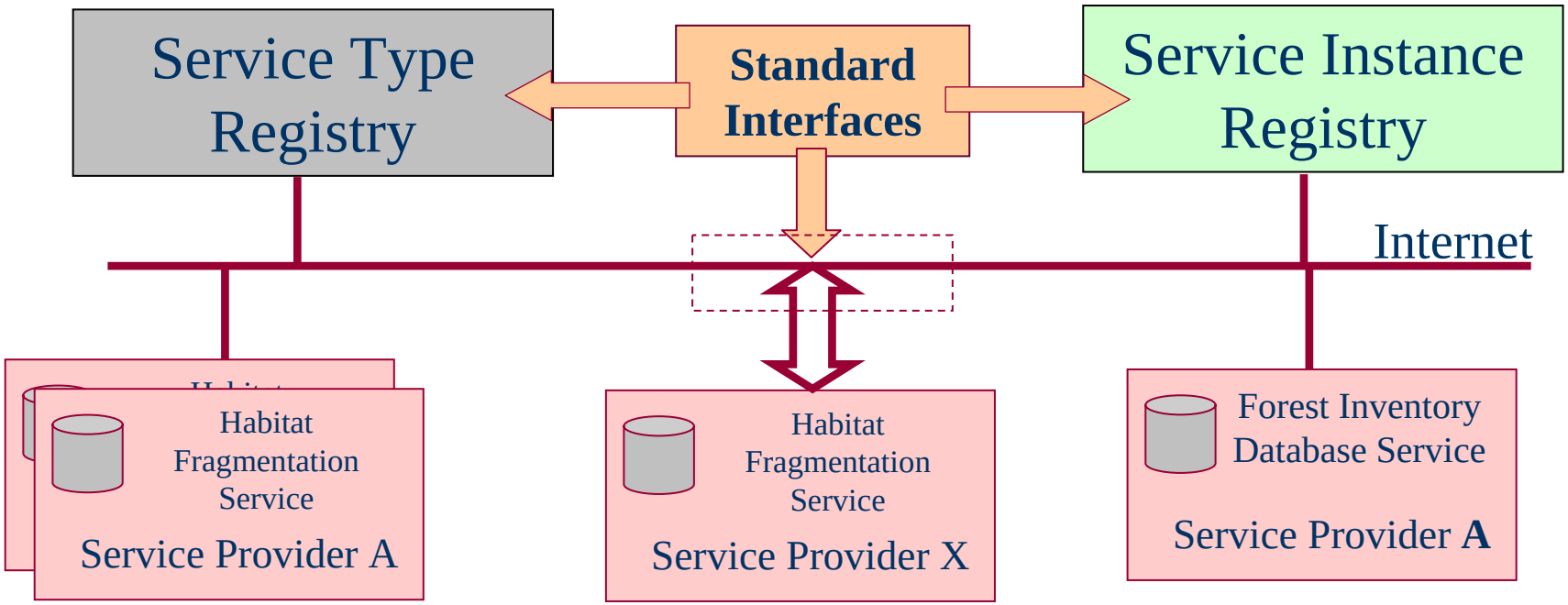
Services can roll-up data from multiple sources



Services can be chained together

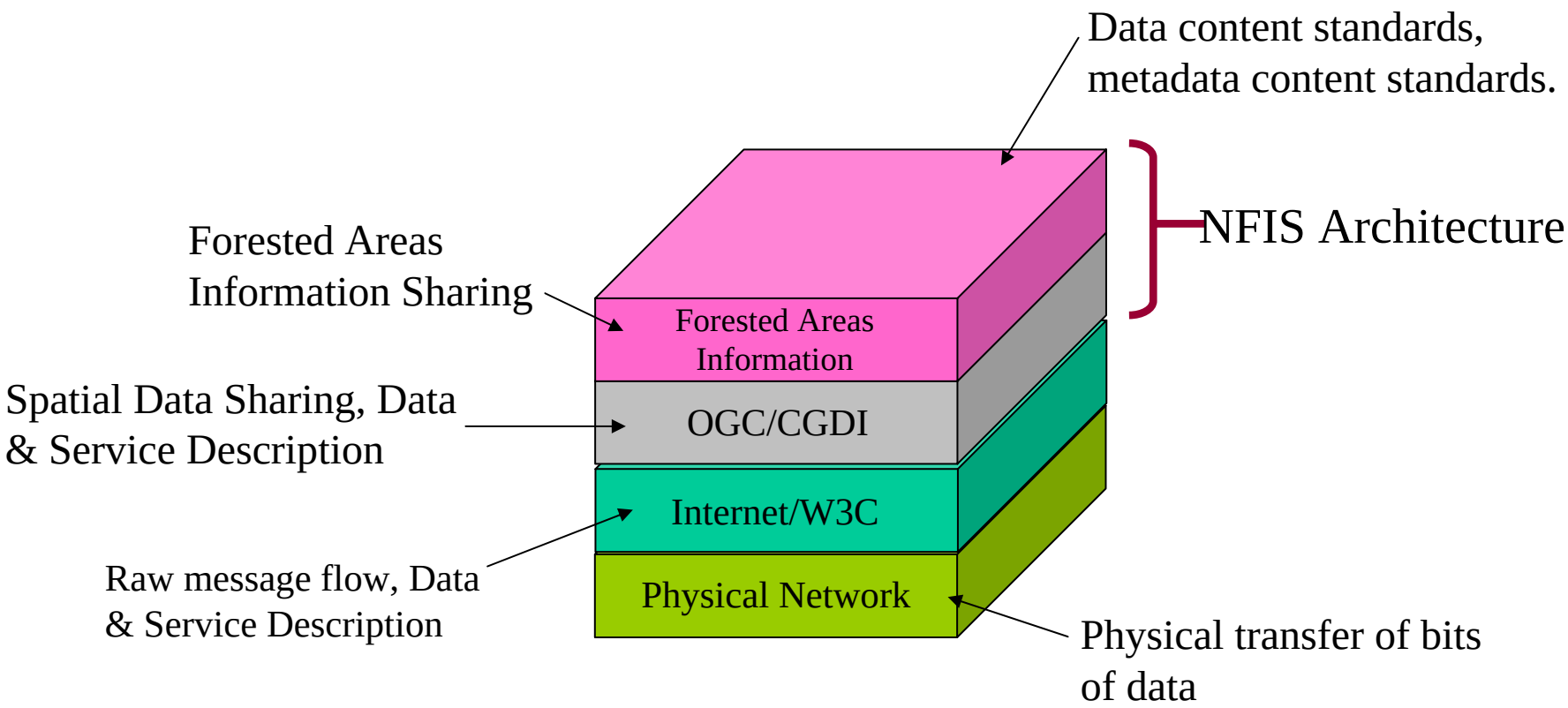


Standard interfaces mean anyone can join!

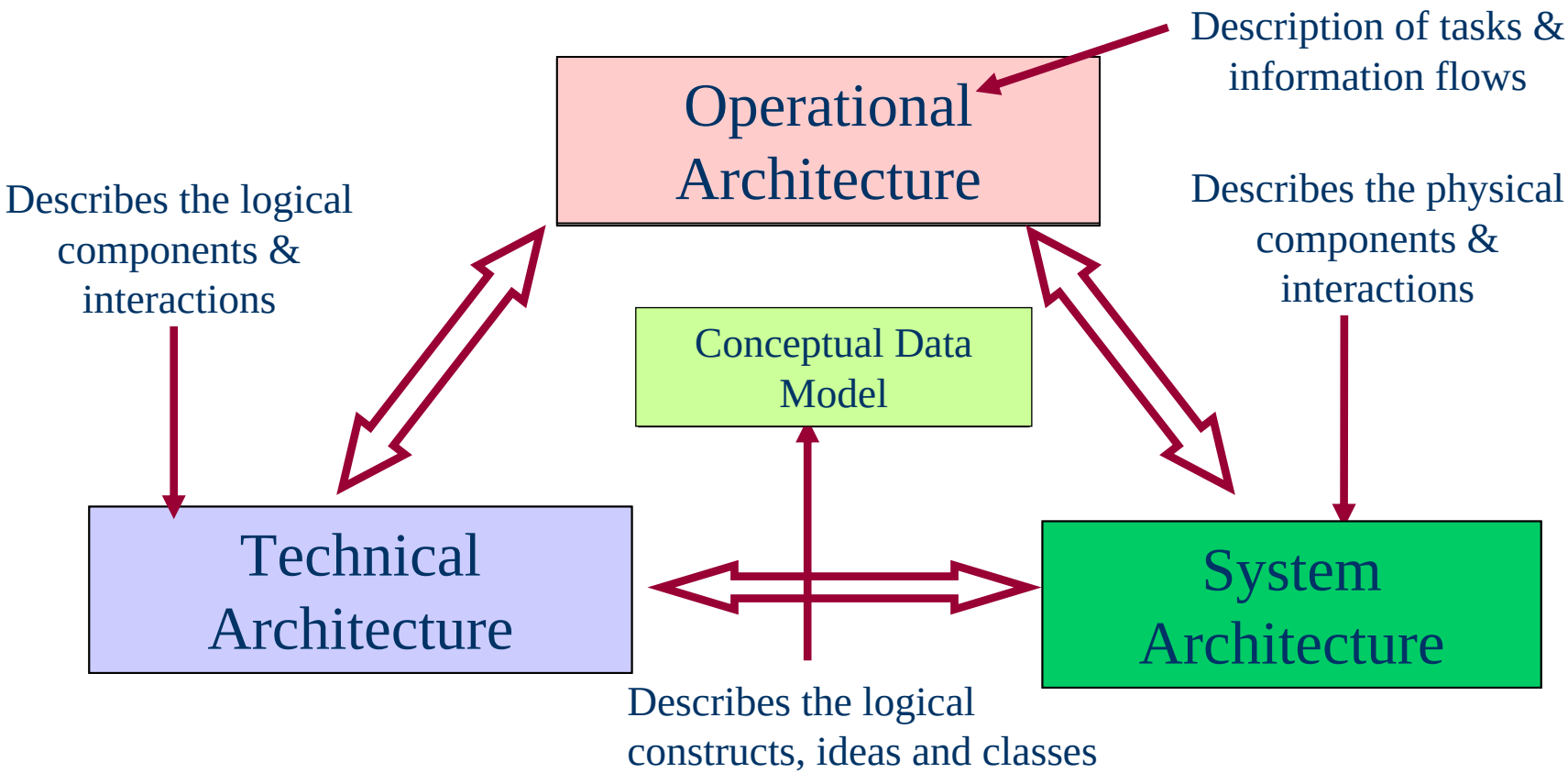


Reference Architecture Description

NFIS Context Picture



C4ISR Architecture Framework



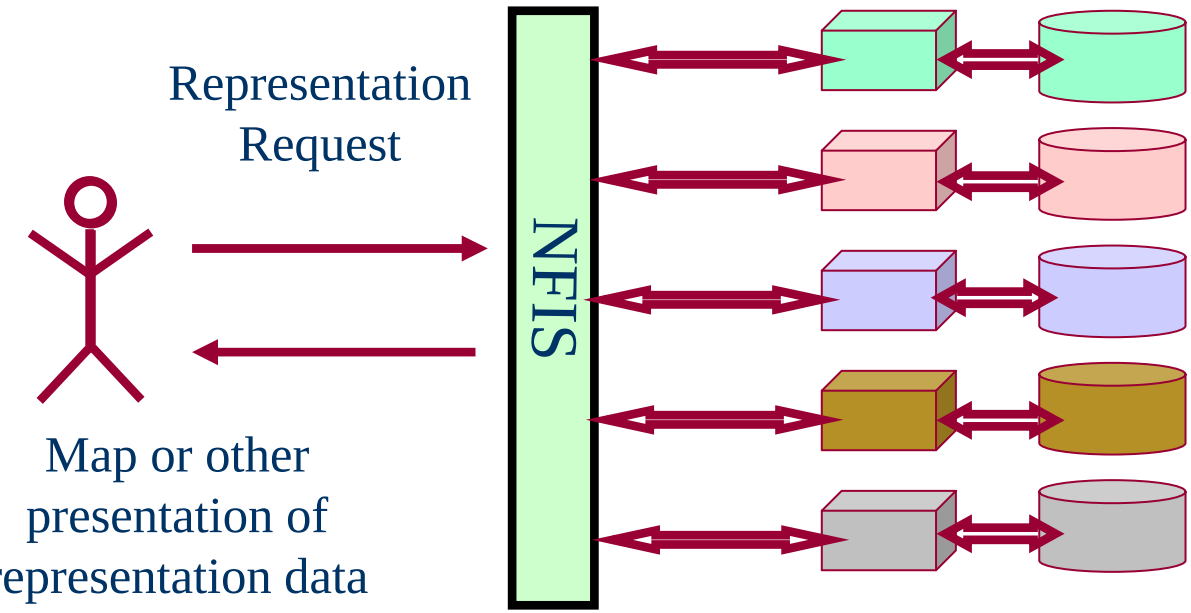
Operational Architecture

The operational architecture view is a "**description of the tasks and activities, operational elements, and information flows required to accomplish or support given task or operation**".

Use Case Overview

- User has a single point of access to information about the state of Canada's forested lands.
- Mapping of user's request to supporting services at national, provincial, regional and local levels is transparent to the requesting user.
- Service suppliers can access standard definitions and schemas to which to map their provincial, regional and local definitions so that a single national picture is presented.
- Mapping transformations are provided by service suppliers to national schema.

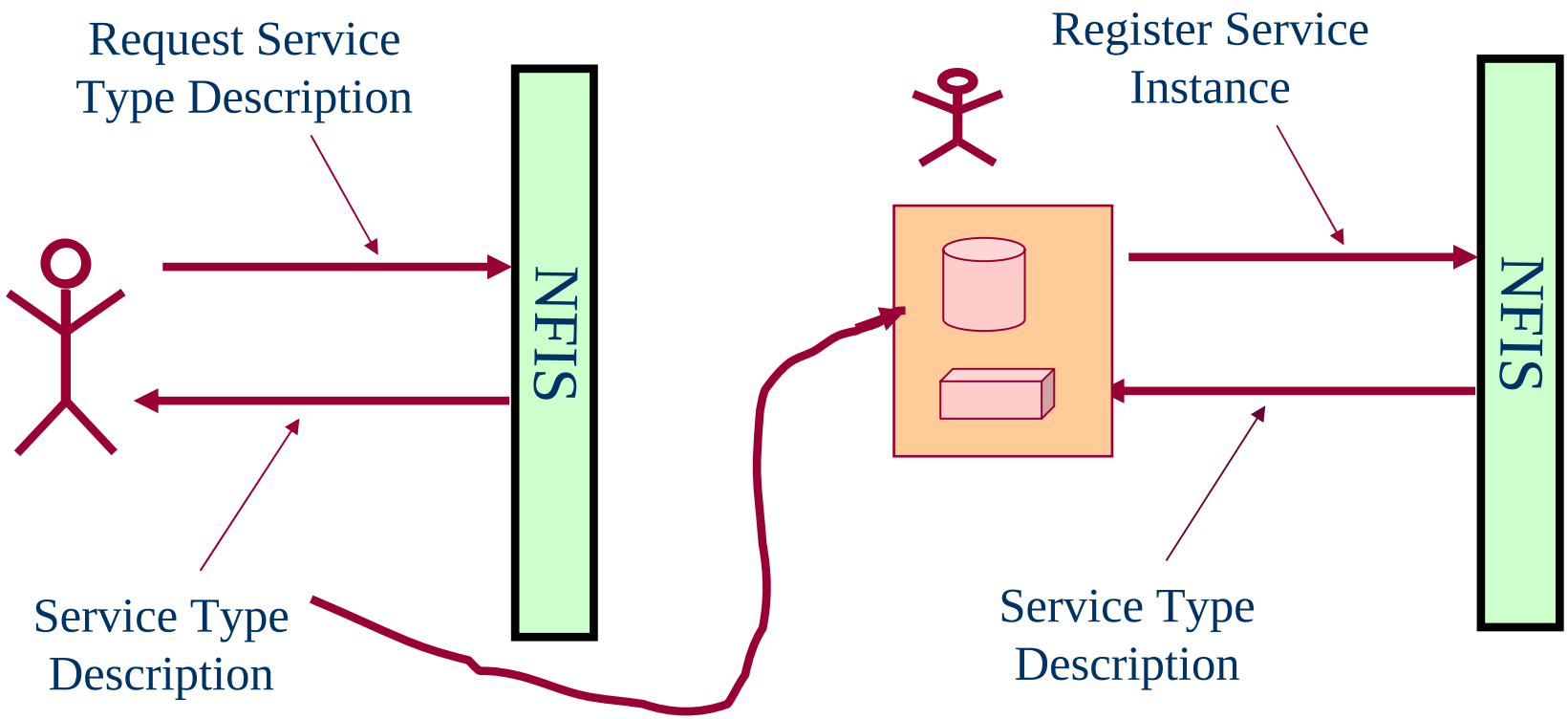
Typical Use Case #1- Data Request



Existing land forms, forest distribution, forest inventory data by province, region or other agencies.

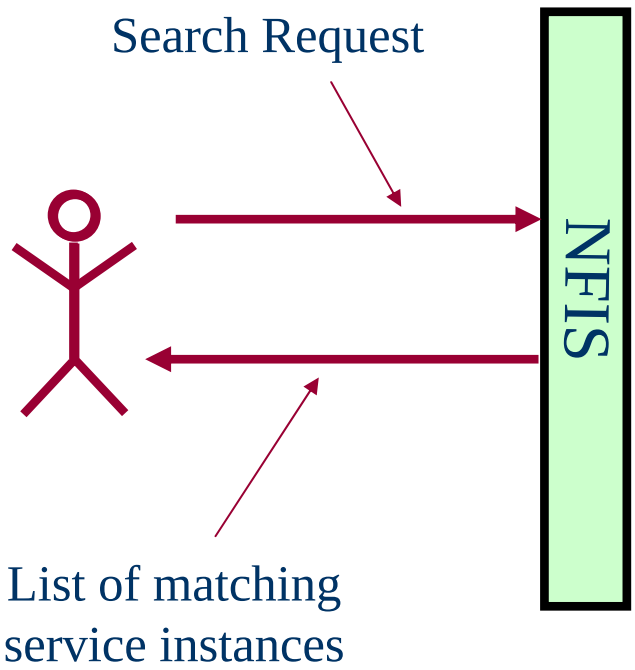
How representative are Canada's protected areas of the boreal eco-system?

Typical Use Case #2 - Connecting a Service

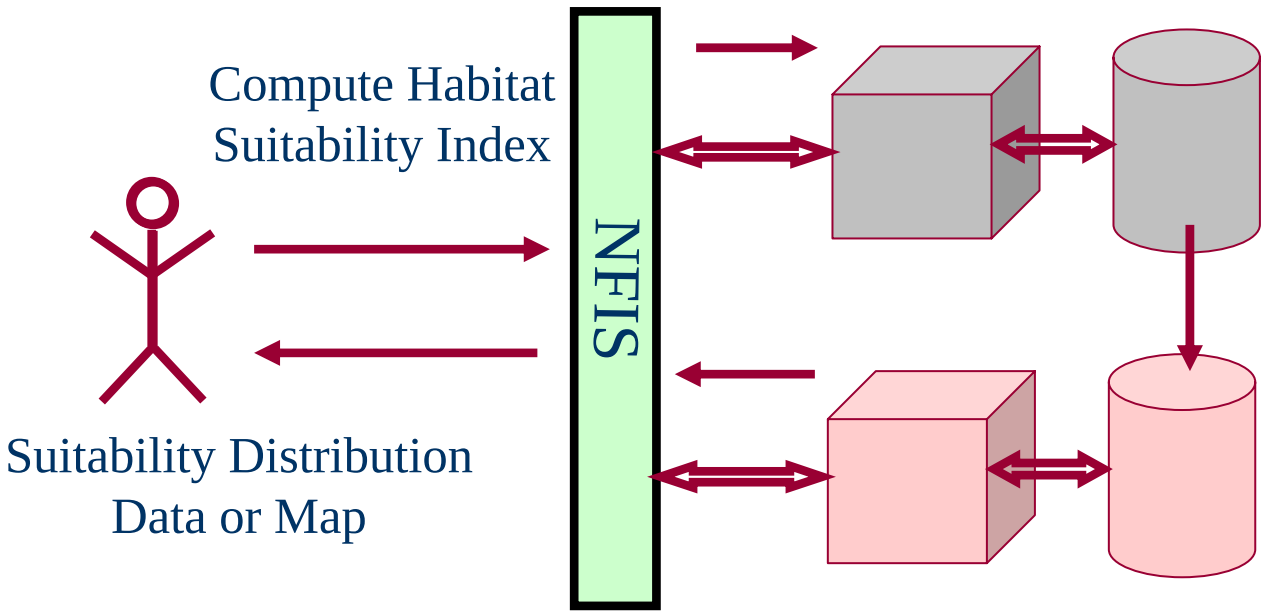


How do we connect a service to the NFIS ?

Typical Use Case #3 - Discovering a Service



Typical Use Case #4 –Data Data Processing Request



Technical Architecture

The technical architecture view is "**the minimal set of rules governing the arrangement, interaction, and interdependence of system parts or elements, whose purpose is to ensure that a conformant system satisfies a specified set of requirements.**"

The technical architecture provides a set of logical system components and their interconnections that is mapped to specific physical systems and software components in the System Architecture. The technical architecture is as implementation independent as possible.

Importance of OGC Standards

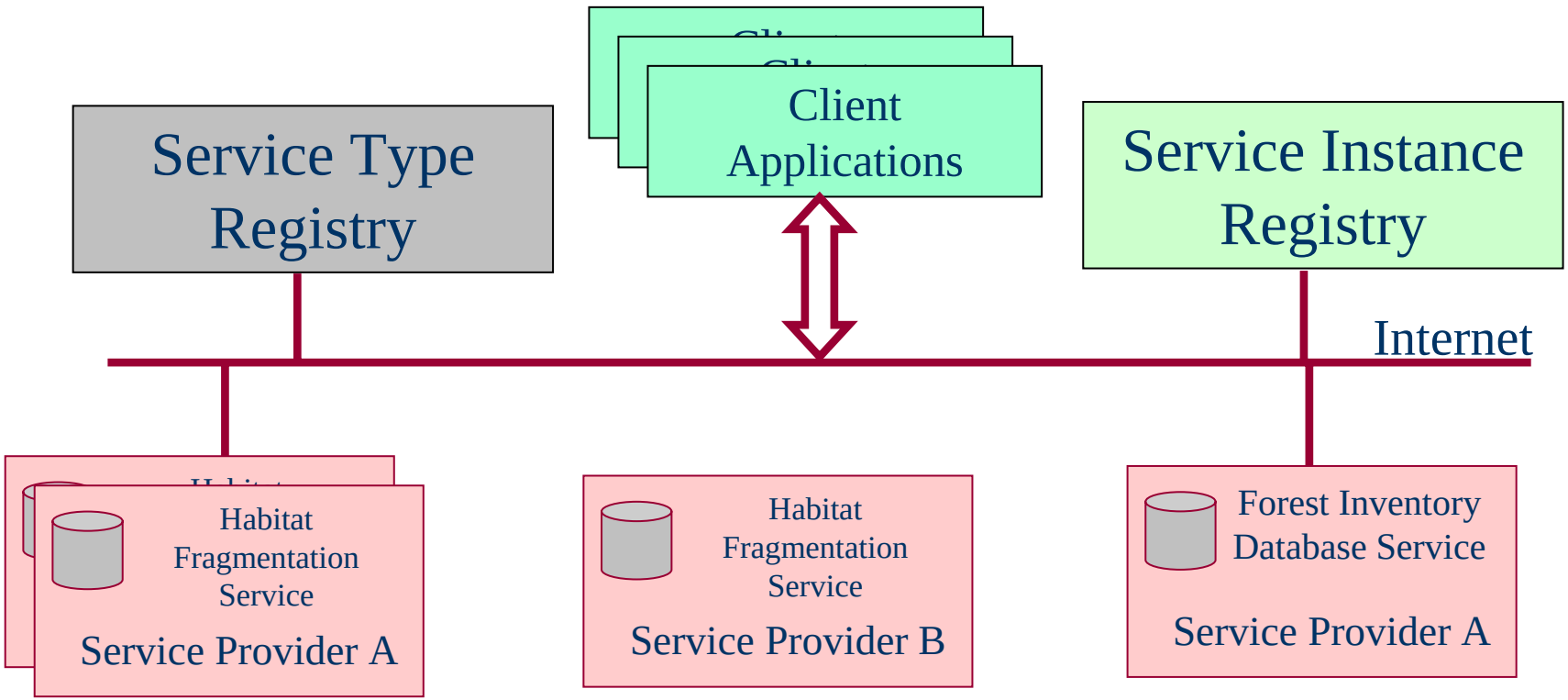
- OGC (OpenGIS Consortium) defines standards for web-based geo-spatial services (data access and data processing).
- OGC Standards define a service-based infrastructure that can be adopted for NFIS with low risk.
- OGC standards are driven and developed by vendors. Standards will appear in commercial products of the OGC members.
- OGC includes all major GIS and Database vendors in the world.
- OGC Standards provide implementations for key ISO TC/211 standards such as features, coverages, temporal schema, metadata, services, reference systems and topology.

NFIS Technical Architecture

The NFIS Technical Architecture is Service-Based Architecture whose “Components” include:

- Client Applications
- Service Instances (Service Instances are instantiations of Service Types).
- Service Instance Registries
- Service Type Repositories

NFIS Technical Architecture

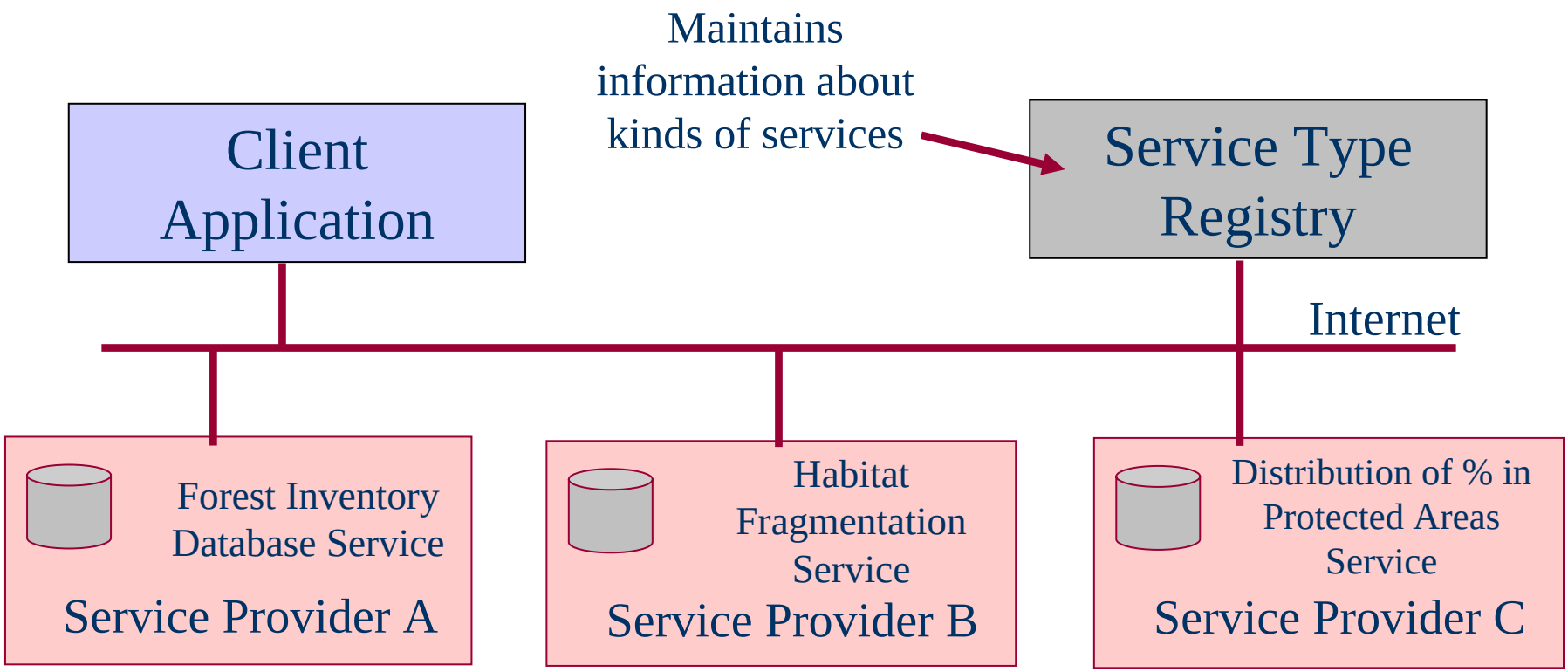


Services offering access to data or data processing

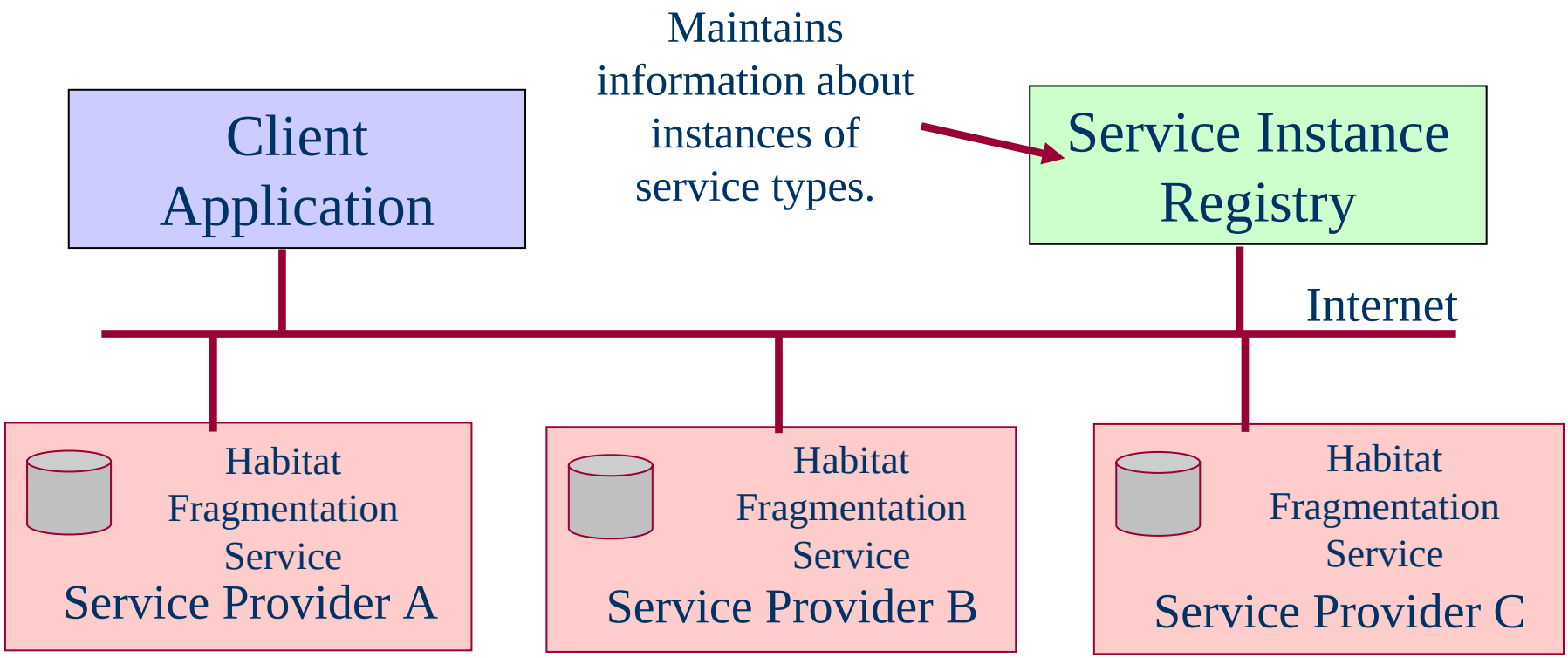
NFIS Technical Architecture

Architecture Component	Description
Client Application	Support interaction with persons or appliances (e.g. sensors). May provide graphical or other forms of data presentation.
Service Instance	Provides data or processing functionality to Client Applications.
Service Instance Registry	Provides information about available service instances (implementations with specific addresses).
Service Type Registry	Provide information about kinds of services. Instance Registry supports discovery. Type Registry supports service providers.

Service Type Registries

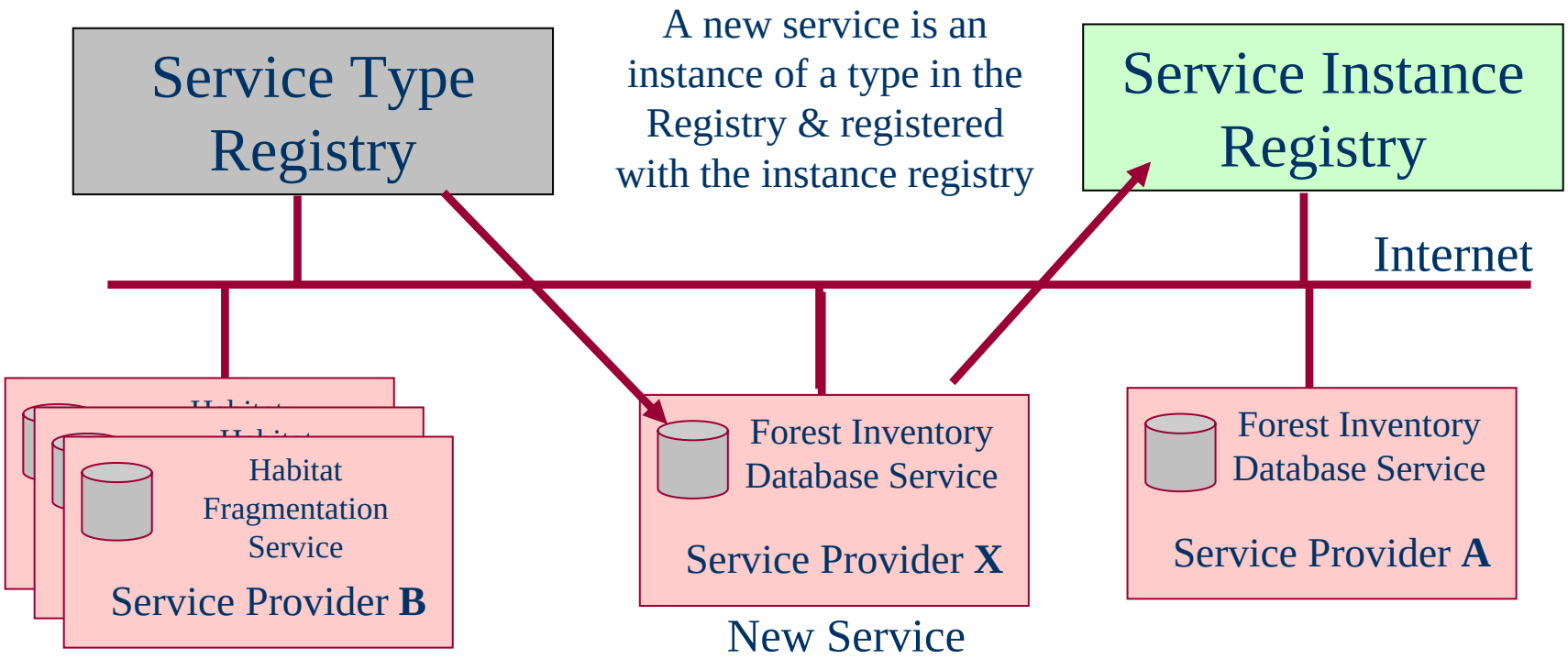


Service Instance Registries



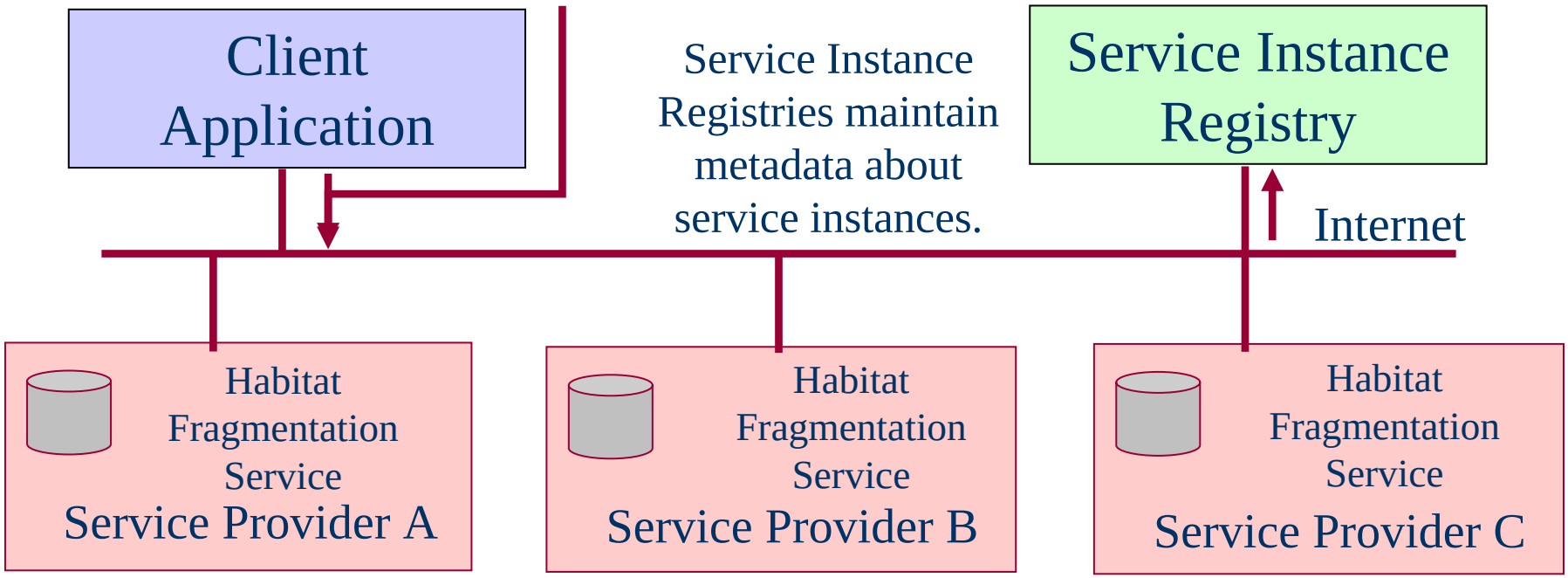
Supplying a Service

Standard protocols and encodings mean new services can be plugged into NFIS

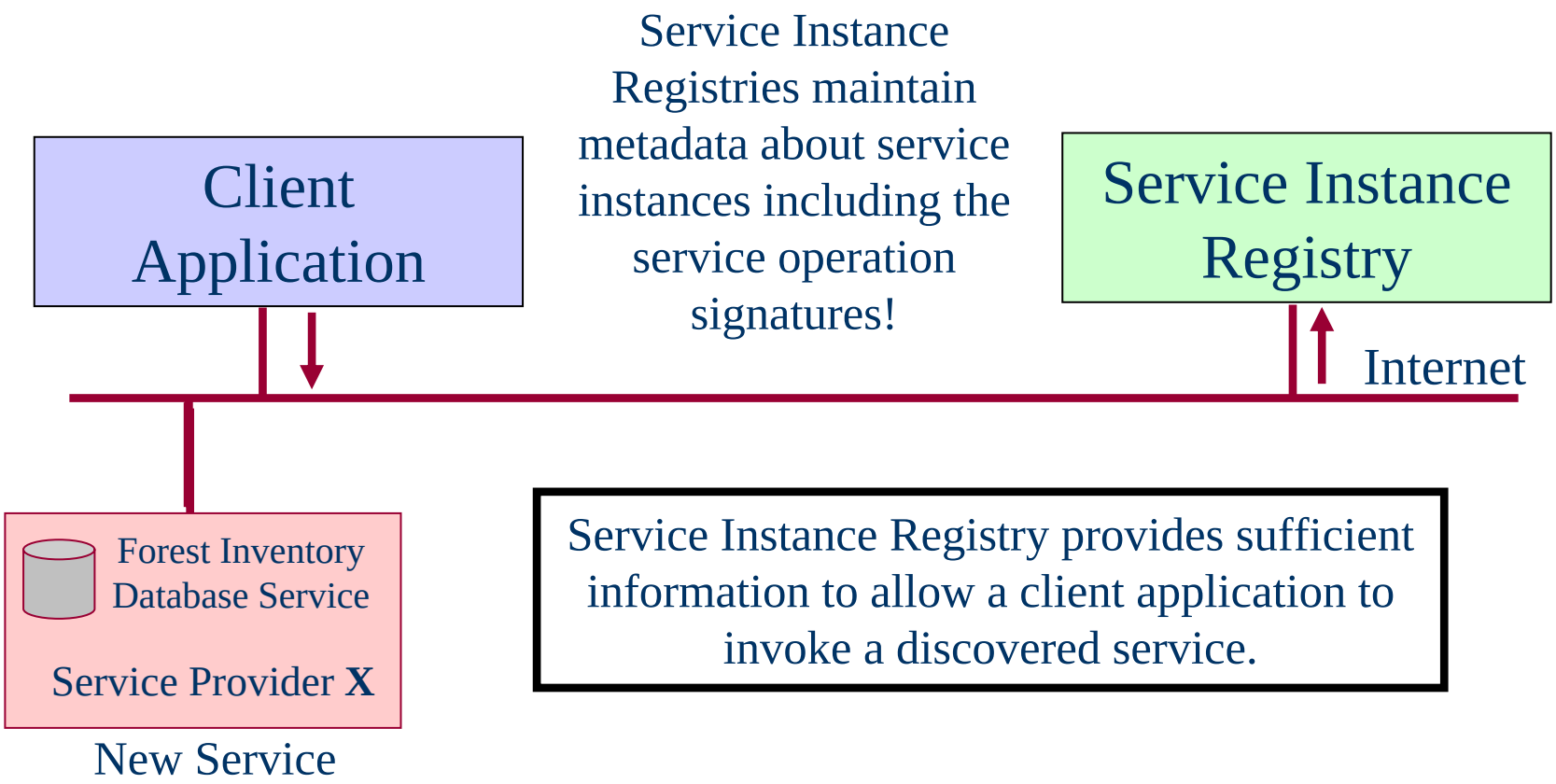


Discovering a Service

Standard request protocol for discovering services based on Service Instance Metadata



Invoking a Service



Role of Standard Interfaces

Interface	Interface Description
Service Instance	Interface descriptions can be obtained from the Service Type Registry for any kind of Service in NFIS. Specific instances of these interfaces can be found in the **Service Type Registry**.
Service Instance Registry	Standard Interfaces support search and discovery of NFIS **Service Instances** based on input/output types, providing agency, purpose etc.
Service Type Registry	Standard Interfaces support search and discovery of **Service Types** (kinds of services) based on input/output types (e.g. input = forest polygon, output = species list).

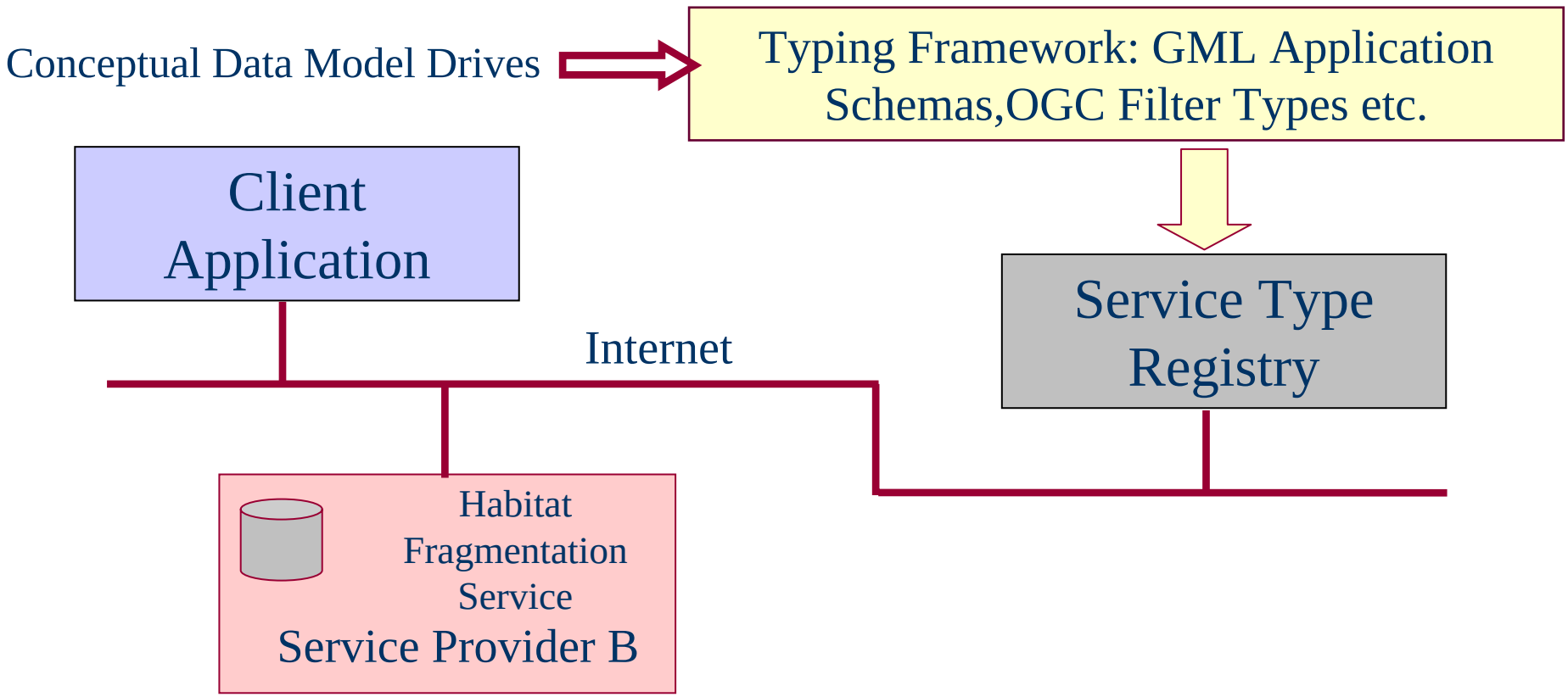
Role of OGC/W3C Standards

Interface	Applicable Interface Standards
Service Instance	**OGC Web Feature Service** (access to feature information), **OGC Web Coverage Service** (access to coverage/distribution function information), **OGC Web Map Service** (access to maps, generation of maps based on feature/coverage data).
Service Instance Registry	**OGC Service Model Specification**. Likely will make use of UDDI at least in part for discovery API.
Service Type Registry	**OGC Service Model Specification**.

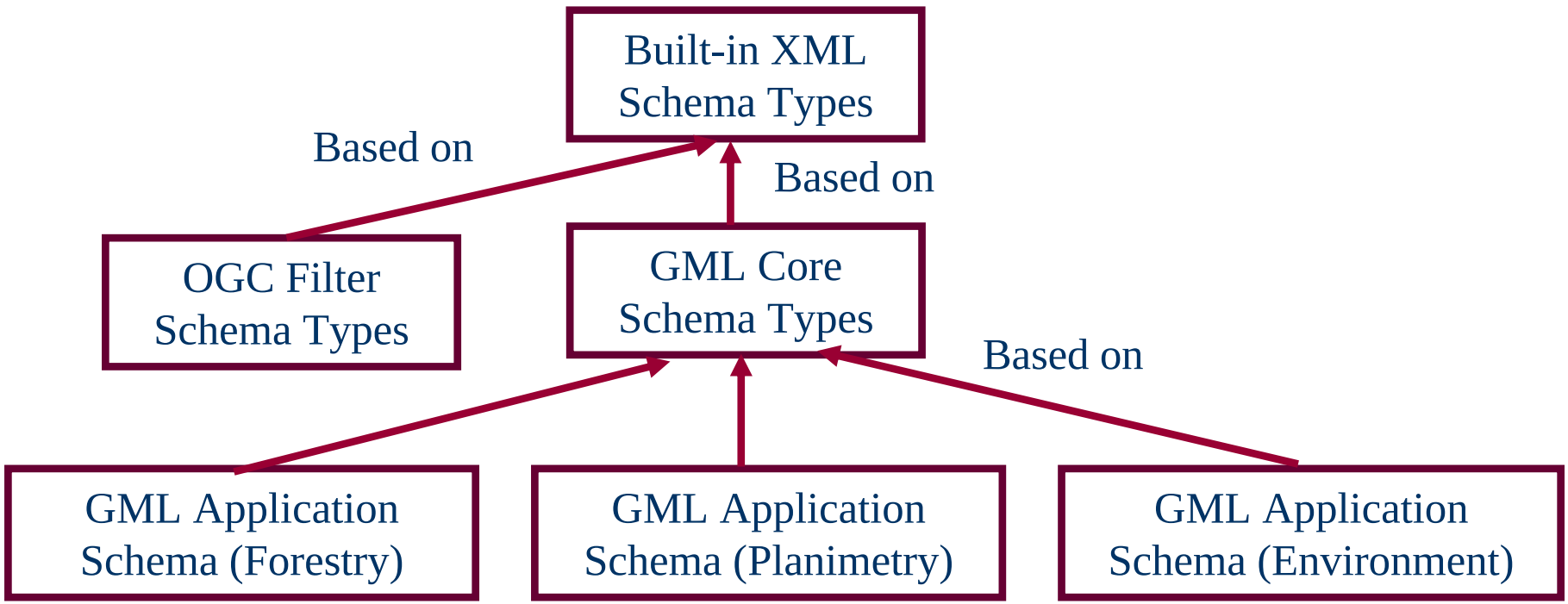
Role of OGC/W3C Standards

Object	Applicable Encoding Specification
Geographic Features & Coverages.	**OGC Geography Markup Language** – describes geometry and provides feature model. Application schemas need to be created for description of forested lands (see Conceptual Data Model). GML 3.0 required for coverage specification.
Service Instances	**OGC Service Model Specification**. This uses W3C **Web Services Description Language (WSDL)** & OGC Typing Frameworks (GML, GML Application Schemas, **OGC Filter Specification**). **Service Metadata Schemas** form part of WSDL type description.
Service Type Registry	This uses W3C **Web Services Description Language** (WSDL) & **OGC Typing Frameworks** (GML, GML Application Schemas, OGC Filter Specification).

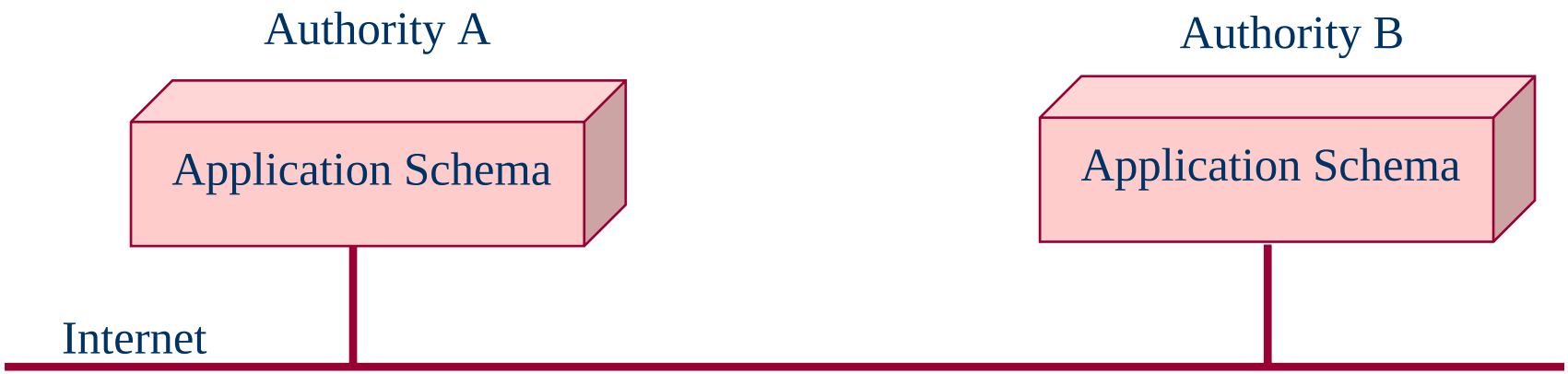
Service Types & Conceptual Data Model



Typing Framework for WSDL



Typing Frameworks



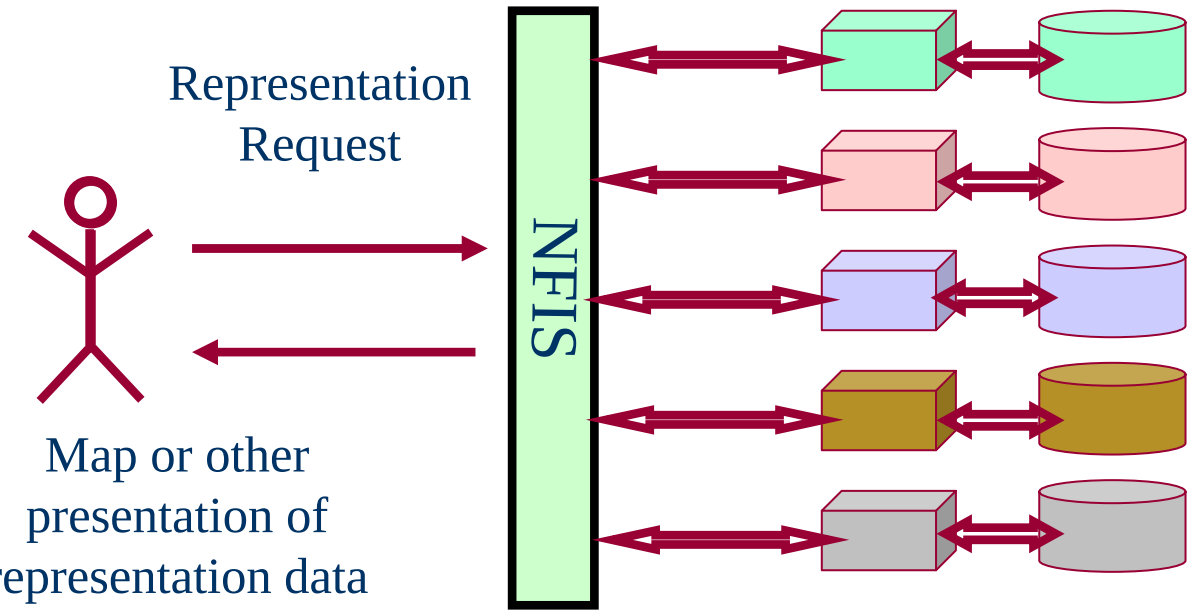
Multiple Application Schemas are anticipated each with its own authority !

Conceptual Data Model

The Conceptual Data Model **provides the abstract ideas and constructs on which the Technical Architecture rests. The vocabulary of the Conceptual Data Model is the means by which the information requests of the operational architecture are expressed.**

The vocabulary and schemas of the conceptual data model provide the framework into which the provincial, national, regional and local information systems map so as to construct a national forest information system.

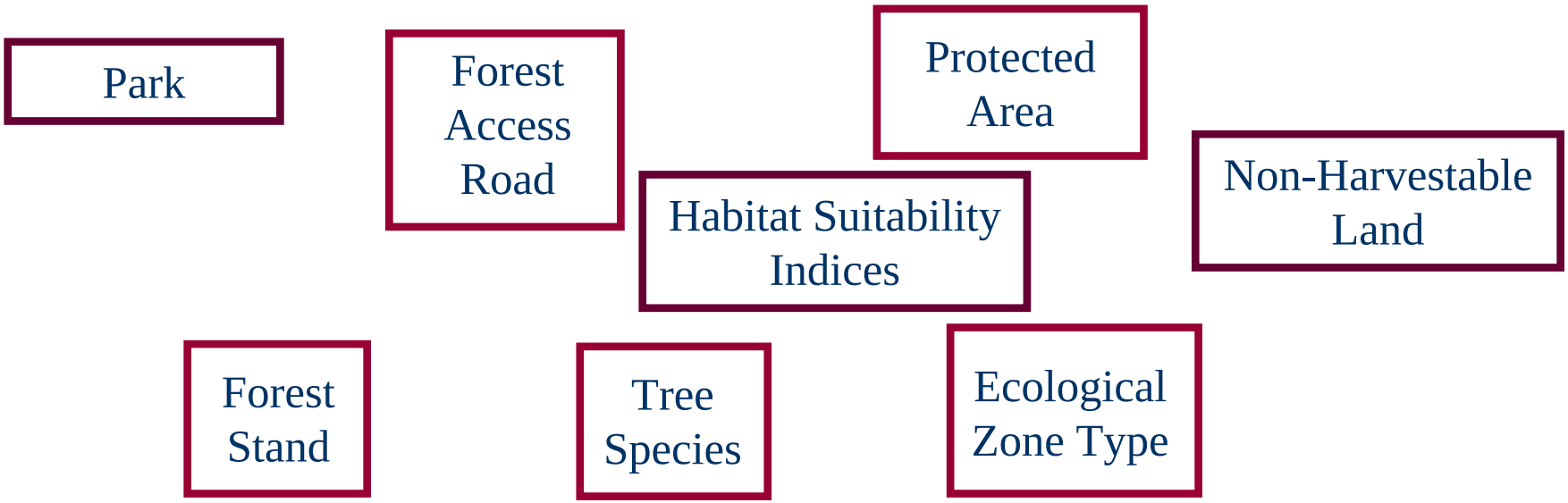
Conceptual Data Model



Land forms, forest distribution, forest inventory data by province, region or other agencies.

To enable a coherent national picture we require coherent national schemas!

Conceptual Data Model



We need to develop a national vocabulary (vocabularies) and schemas

System Architecture

- The systems architecture view is a "**description, including graphics, of systems and interconnections providing for, or supporting, user activities.**.
- For a domain, the systems architecture view shows how multiple systems link and interoperate, and may describe the internal construction and operations of particular systems within the architecture.
- For the individual system, the systems architecture view includes the physical connection, location, and identification of key nodes (including materiel item nodes), circuits, networks, user platforms, etc., and specifies system and component performance parameters (e.g., mean time between failure, maintainability, availability). The systems architecture view associates physical resources and their performance attributes to the operational view and its requirements per standards defined in the technical architecture."

Performance Criteria

- NFIS Service Instance Type Registries must enable retrieval of a service instance description (via a web-based client) in at most a few tens of seconds. Typical response time should be a few seconds.
- NFIS Service Type Repositories must enable retrieval of a service type description (via a web-based client) in at most a few tens of seconds. Typical response time should be a few seconds.
- NFIS itself does not impose any service invocation overhead. For services that are invoked through protocol translators the overhead of such translation should be no more than a few seconds.
- More detailed performance criteria need to be developed for specific types of NFIS services (e.g. rollup of provincial inventories)

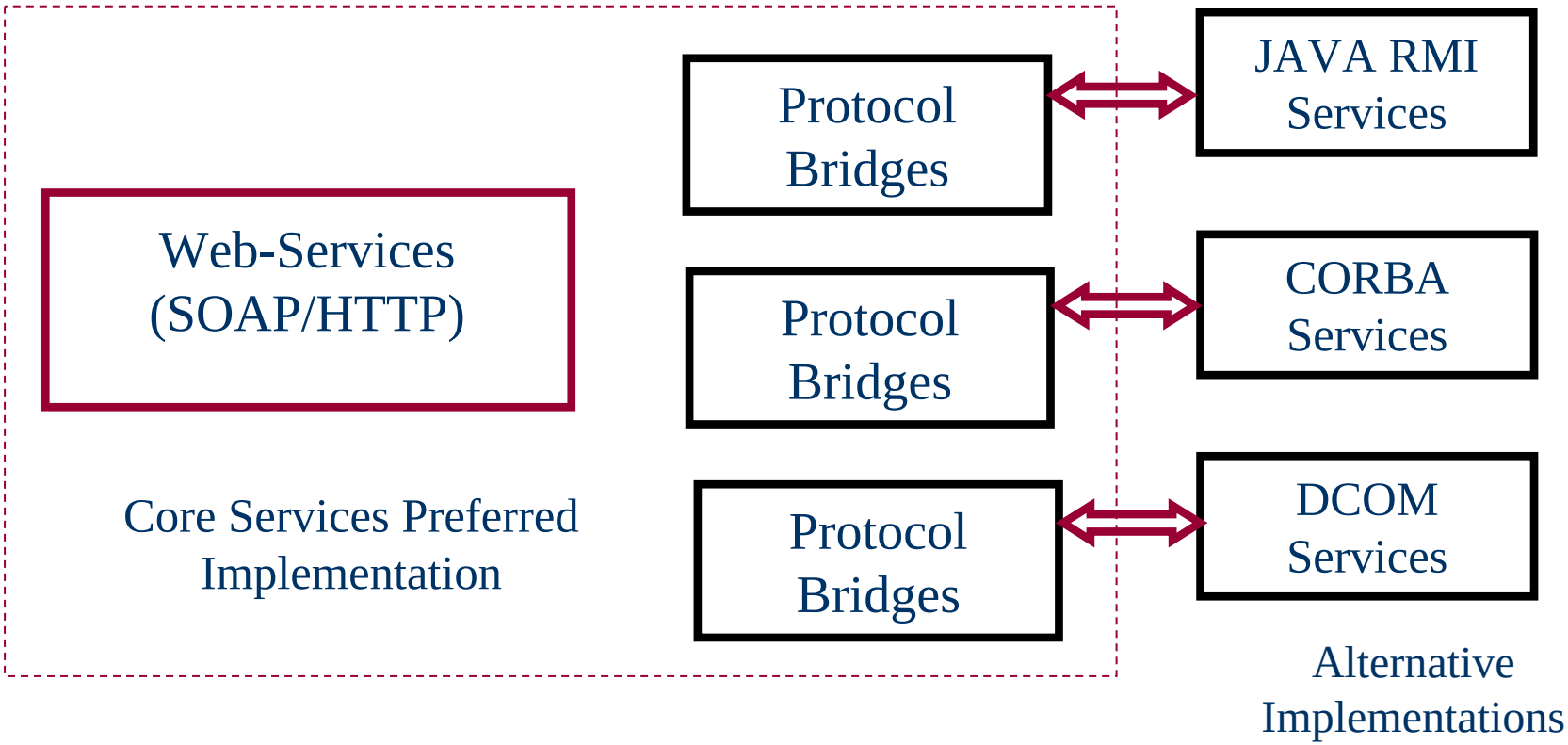
NFIS Implementation

- Variety of distributed infrastructure technologies could be used to build services and core components of the service infrastructure. NFIS should admit all of the major technology approaches including:
  - SOAP (Simple Object Access Protocol)
  - Java RMI/J2EE
  - DCOM/MS DNA
  - CORBA
  - MS.NET

NFIS Implementation

- NFIS Core Services (e.g. Service Type Registry, Service Instance Registry) should be implemented in one technology to begin with and others used as market demands.
- Protocol bridges (commercial & custom) allow incorporation of service providers (including additional service instance registries and service type repositories) using other technologies. This enables NFIS to support CORBA, DCOM, Java RMI etc.
- Decision on initial technology for NFIS core services implementation should be made based on current market and technology directions for web-services.

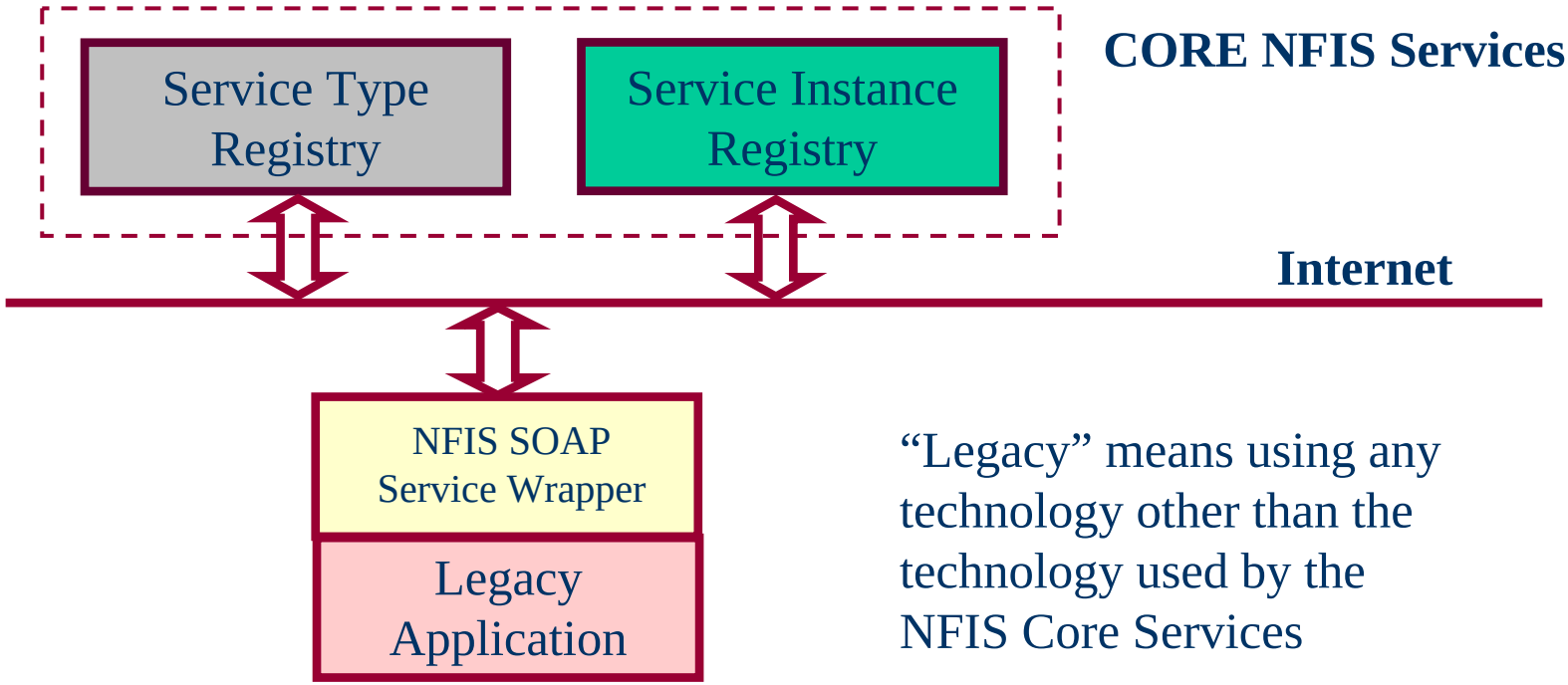
NFIS Implementation



NFIS Core Services Implementation

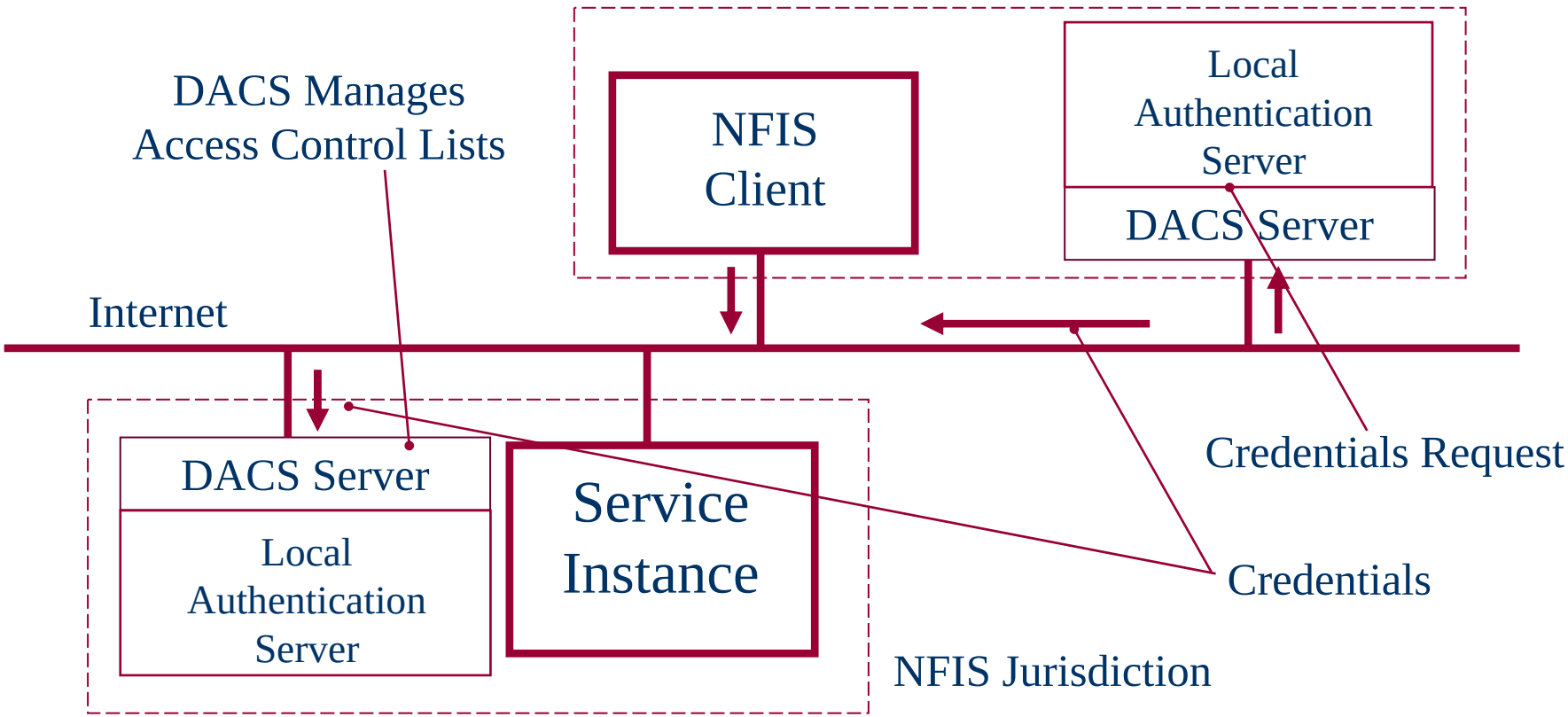
Component	Preferred Implementation
Service Type Registry	SOAP-based implementation of OGC Compliant Service Type Registry providing W3C WSDL-based descriptions of service types (WSDL Port Types) with associated service metadata.
Service Instance Registry	SOAP-based implementation of OGC Compliant Service Instance Registry providing W3C WSDL-based description of service instances including addresses, bindings and metadata.
Service Instances	SOAP and HTTP based service skeletons that can wrap legacy applications so as provide as NFIS services. All other services are provided by NFIS "participants" in provincial, federal, municipal agencies, private sector companies and NGO's.

NFIS Service Implementation



"Legacy" means using any technology other than the technology used by the NFIS Core Services

NFIS Security



NFIS and Current Commercial Products

- Most major GIS & Database Vendors are expected to provide OGC compliant web-service implementations in the next year.
- Prototype products are available from many vendors including ESRI (IMS support for OGC WMS and developing a WFS), Intergraph (developing a WFS and have WFS client support), IBM/Informix (Developing a WFS capability), SmallWorld (WFS capability), CubeWerx (WFS, WMS).
- More advanced web-services implementations (WFS, WCS) are anticipated from most vendors including Galdos Systems, CubeWerx, Oracle, MapInfo and ESRI.

OGC Compliant Services and NFIS

- Web Feature Service – provides fine-grained access to geographic features like roads, forest stands, and rivers.
- Web Coverage Service – provides access to coverage data such as elevation models, remotely sensed imagery, and soils distribution.
- Service Type Registry – provides discovery, update, retrieval interfaces for WSDL-based service type descriptions. Contains description of generic OGC Services like WFS, WCS and more specific ones for sustainable forest management.
- Service Instance Registry – provides discovery, update and retrieval interfaces for WSDL-based descriptions of service instances.

Technical References

- **Web Services Description Language (WSDL)** (http://www.w3.org/TR/wsdl)
- **Universal Description Discovery and Integration** (UDDI) (http://www.uddi.org/pubs/ProgrammersAPI-V2.00-Open-20010608.pdf)
- **WSDL in UDDI** (http://www.uddi.org/pubs/wsdlbestpractices-V1.05-Open-20010625.pdf)
- **UDDI Taxonomies** (http://www.uddi.org/pubs/bp-taxonomy-provider-V1.00-Final-20010717.pdf)
- **Geography Markup Language** (GML 2.0) (http://www.opengis.net/gml/01-029/GML2.html)
- **Java 2 Enterprise Edition (J2EE)** (http://java.sun.com/j2ee/)

Technical References

- **.Net** (http://www.microsoft.com/net/) **Microsoft Web Services**
- **Common Object Request Broker Architecture (CORBA)** (http://www.corba.org/)
- **Microsoft Distributed Network Architecture (DNA)** (http://www.cicacm.org/MSDNA.htm)
- **Simple Object Access Protocol (SOAP)** (http://www.oasis-open.org/cover/soap.html)

Technical References

SOAP Resources:

- Microsoft Toolkits and Resources (http://msdn.microsoft.com/library/default.asp?url=/nhp/Default.asp?contentid=28000523)
- IBM Toolkits and Resources (http://www-106.ibm.com/developerworks/webservices/)
- SOAP Client Resource Site (http://www.soapclient.com/Resources.html)

Technical Resources

- WSDL Resources:
  - Microsoft (http://msdn.microsoft.com/library/?url=/library/en-us/dnwebsrv/html/wsdl.asp?frame=true)
  - IBM Web Services (http://xml.coverpages.org/ni2001-02-19-b.html)
  - General (http://www.anomaly.org/wade/thesis/index.html)

Glossary of Terms

TERM	DEFINITION
API	Application Programming Interface
ASP	Active Server Page (Microsoft)
C4ISR	Command, Control, Communications
CGDI	Canadian Geo-spatial Data Infrastructure
CGI	Common Gateway Interface (HTTP Server mechanism to invoke scripts or other executable programs)
CORBA	Common Object Request Broker Architecture (OMG Distributed Computing Platform)
COM	Component Object model (Microsoft)
COVERAGE	Distribution function for a property over portion of the earth's surface (OGC term)

Glossary of Terms

TERM	DEFINITION
DCOM	Distributed Component Object Model. Microsoft Distributed Computing Platform.
DNA	Microsoft Distributed Network Architecture
EJB	Enterprise Java Bean. Transactional component in J2EE System. Equivalent to COM object under MTS in Microsoft DNA.
Feature	OGC Term denoting a concrete or abstract geographic object.
GML	OGC Geography Markup Language
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol over SSL (secure HTTP)
IIOP	Internet Inter-Orb Protocol (a CORBA wire protocol)
ISO	International Standards Organization
J2EE	Java 2 Enterprise Edition – Java Framework for web-services.

Glossary of Terms

TERM	DEFINITION
JSP	Java Server Page – J2EE Equivalent of ASP in DNA
MTS	Microsoft Transaction Server (provides transaction control of COM objects within DNA environment)
.Net	Microsoft Web Services Platform
NFIS	National Forest Information System
NGO	Non-government Organization
OGC	OpenGIS Consortium
ORPC	Object Remote Procedure Call (a DCOM Wire Protocol)
RMI	Remote Method Invocation (part of J2EE Distributed Computing Platform)
SOAP	Simple Object Access Protocol

Glossary of Terms

TERM	DEFINITION
SQL	Structured Query Language
SSL	Secure Socket Layer
UDDI	Universal Description, Discovery and Integration
WCS	Web Coverage Service (OGC)
WFS	Web Feature Service (OGC)
WMS	Web Map Service (OGC)
WSDL	Web Services Description Language (W3C Specification)
W3C	World Web Wide Consortium
XML	eXtensible Markup Language