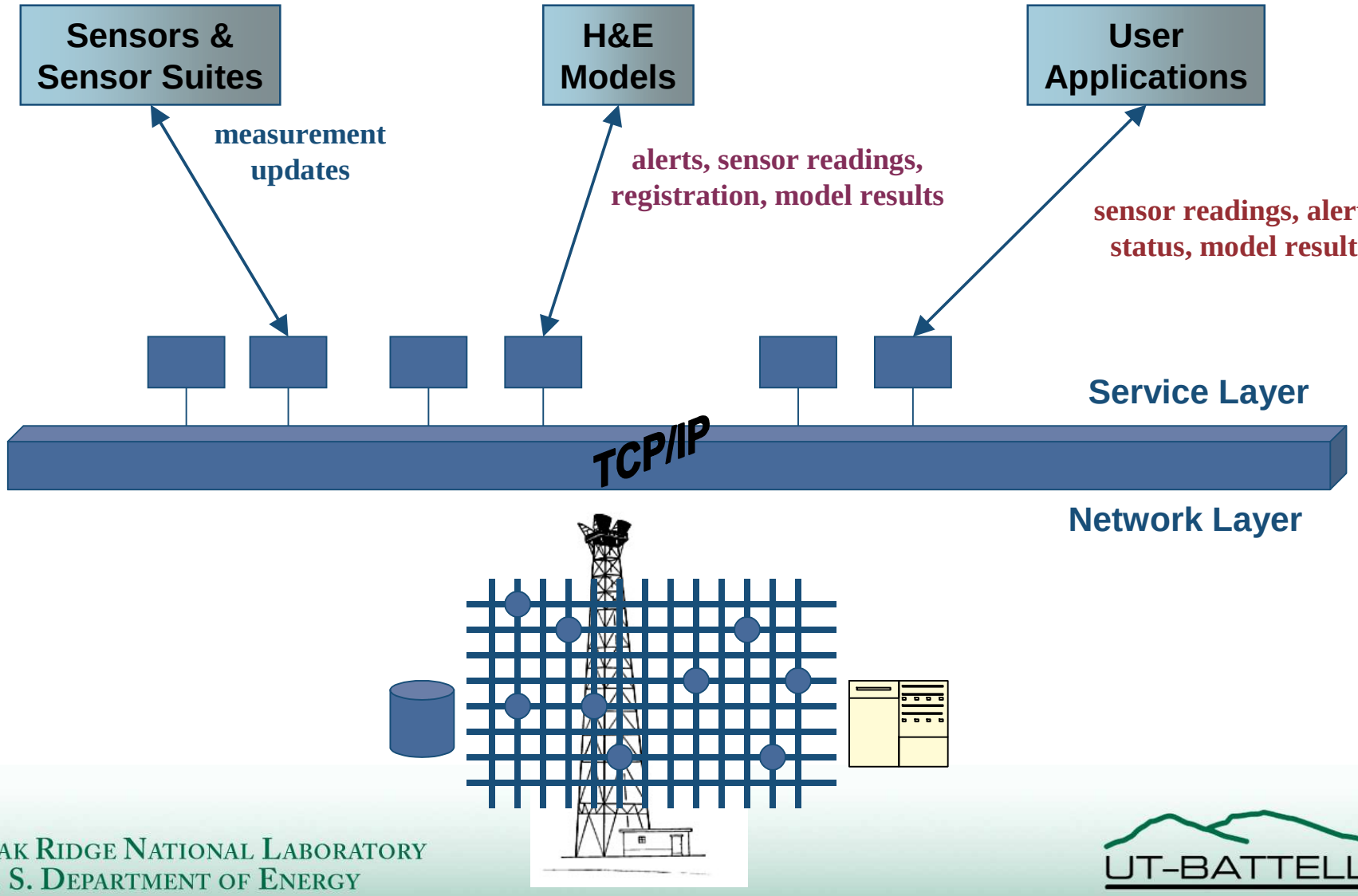
SensorNet Application/Service Layer



Application/Service Layer Ideals

- **All communciation issues handled at lower layers**
- **No special interface software**
  - **Custom protocol stacks**
  - **Special networking libraries**

Application/Service Layer Goals

- **Common interfaces for**
  - **Sensors and sensor suites**
  - **Models**
  - **User/operator applications**
- **Hide details and effects of**
  - **Transport layer networking (and below)**
  - **Data architecture and its implementation**
- **Ride the wave of standards**
  - **Web services**
  - **SOAP**

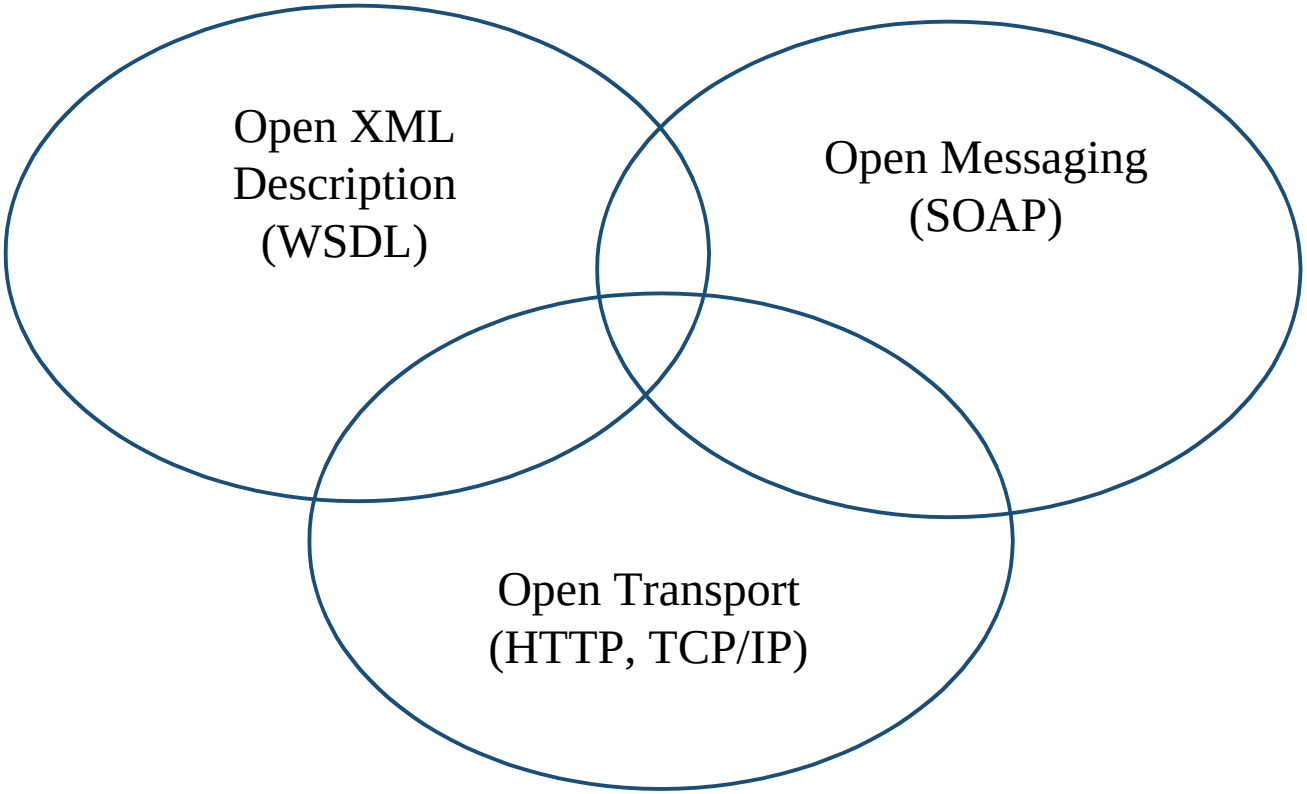
Approaches

- **Suggest a service-oriented "API" for SensorNet**
  - **Build to interfaces and schema**
- **SOAP**
  - **Leverages standardization activities**
  - **XML Encryption**
  - **XML Signatures**
  - **SAML**
  - **Project Liberty**
- ***Spec*-itecture**
  - **Standards and interfaces**

Domain Patterns

- **Self service**
- **Collaboration**
- **Context aggregators (portal)**
- **External processing/extended enterprise**

State of Web Services



Application/Service Security

- **Authentication**
- **Identity propogation**
- **Authorization**
- **Encryption**
- **Non-repudiation**

Web Services

- **Ambiguous term with its own range of meanings**
- **Generally, communication of XML documents across HTTP**
- **Can mean**
  - **REST**
  - **SOAP-RPC**
  - **Document style SOAP**

Communication Approaches

- **Range of network and transport layer options**
  - **Closed, application-specific**
    - **Socket level exchange of packed binary message content**
  - **Distributed object middleware, structured**
    - **CORBA**
  - **Service-oriented, structured**
    - **SOAP**
  - **Service-oriented, unstructured**
    - **REST**

Web Services

- **REST architectural style**
  - **Representational State Transfer**
    - http://www.ics.uci.edu/~fielding/pubs/dissertation/top.htm
    - http://www.prescod.net/rest/
  - **Distinguishing characteristics**
    - **Uniform interface between components**
    - **Key abstraction is a *resource*, anything that can be the target of a URI/URL**
    - **HTTP verbs are enough (GET, PUT, POST, DELETE, etc.)**
    - **URLs identify resources**
    - **Web of linked resources**

Web Services

- **SOAP-RPC**
  - **Simple Object Access Protocol, Remote Procedure Call**
  - **Most common interpretation of “Web services”**
  - **Heavily supported with tools**
  - **Web Services Description Language (WSDL) to describe service interface and end points**
  - **Universal Description, Discovery, and Integration (UDDI) services to find Web services**

Web Services

- **SOAP-RPC Issues**
  - **Rather difficult to deal with complex data**
    - **Limitations in XML Schema definitions**
    - **Cannot specify variant (IDL *Any*) fields or parameters**
  - **Service bound to WSDL definition**
    - **Just as CORBA servant bound to IDL definition**
    - **Although WSDL processed at run time, programmer must know interfaces and semantics of the call**
    - **Tightly coupled, fine grain**
  - **Paul Prescod's arguments for REST**
    - **`http://www.prescod.net/rest/rest_vs_soap_overview/`**
    - **`http://www.sys-con.com/xml/article.cfm?id=454`**

Web Services

- **Document style SOAP**
  - **SOAP message envelopes but not RPC**
    - **Use header for message-level services, like security**
  - **Compromise between RPC and REST?**
  - **Loosely coupled, coarse grain**
  - **Transmit XML document in SOAP body**
    - **Can specify schema in WSDL "contract"**
    - **Schema and/or content can change (non-destructively) without changing messaging infrastructure**
  - **SOAP with attachments (SwA) can include binary attachments**

Web Services

- **Document style SOAP (cont'd)**
  - **Can use any transport medium**
    - **Socket**
    - **HTTP servlet or CGI**
    - **Messaging service**
  - **Example: DocSOAP from CommerceOne**
    - **http://www.commerceone.com/developers**
- **Document style in general used by OpenGIS Web Services Initiative specifications**

Examples

```
<snet:request xmlns:tns="http://service.snet.ornl.gov/request"
    xmlns:snet="http://service.snet.ornl.gov/SNet">
  <snet:GetSites spatialDomain="-79,35,5,5"/>
  <!-- SAML assertions ? - ->
</snet:request>
```

```
<snet:response xmlns:snet="http://service.snet.ornl.gov/SNet"
    xmlns:tns="http://service.snet.ornl.gov/response">
  <timestamp>20030731151700</timestamp>
  <Sites count="12">
    <Site>
      <SiteID>DC005</SiteID>
      <SiteName>Arboretum</SiteName>
      <Latitude>38.9160995</Latitude>
      <Longitude>-76.9688034</Longitude>
      <City>Washington</City>
      <State>DC</State>
    </Site>
    …
  </Sites>
</snet:response>
```

Examples

```
<snet:request xmlns:tns="http://service.snet.ornl.gov/request"
    xmlns:snet="http://service.snet.ornl.gov/SNet">
  <snet:GetSensorReadings
      spatialDomain="-77.24,38.787811,0.378004,0.222189"
      time="200307301800"/>
</snet:request>
```

```
<snet:response xmlns:snet="http://service.snet.ornl.gov/SNet"
    xmlns:tns="http://service.snet.ornl.gov/response">
  <timestamp>200307301801</timestamp>
  <SensorReadings count="7">
    <Station>
      <SiteID>DC005</SiteID> <SiteName>Arboretum</SiteName>
      <Date>20030730</Date> <Hours>18.00</Hours>
      <Latitude>38.9160995</Latitude> <Longitude>-76.9688034</Longitude>
      <BattVolts>12.81</BattVolts> <RelHumidity>26.97</RelHumidity>
      <TempBar>1.212</TempBar> <TempMax>1.588</TempMax>
      <TempMin>0.658</TempMin> <TempStdDev>0.161</TempStdDev>
      <WindDir>239.1</WindDir> <WindDirStdDev>24.53</WindDirStdDev>
      <WindSpeed>1.327</WindSpeed> <WindVecMag>1.205</WindVecMag>
    </Station>
    …
  </SensorReadings>
</snet:response>
```

Grid Services

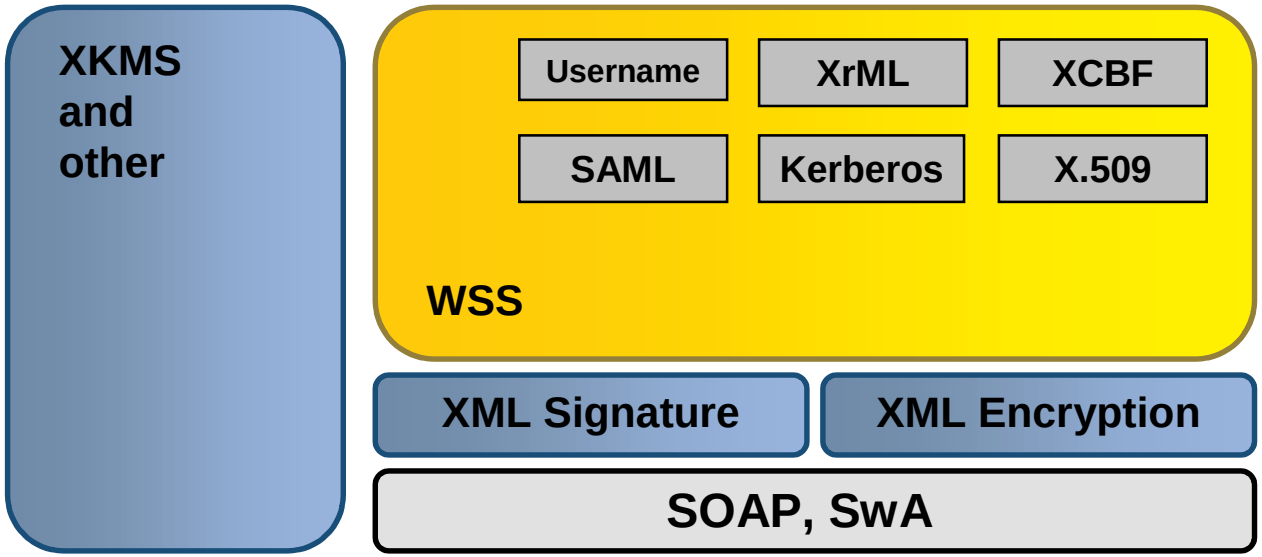
- **Grid concepts**
  - **Coordinated resource sharing and problem solving**
  - **Virtual organizations**
  - **Computational, data, and access grids**
- **Globus project toolkit 3**
  - **Based on Open Grid Services Architecture (OGSA)**
  - **Implements Open Grid Services Infrastructure (OGSI)**
    - **“Standard web services” supporting grid computing**
  - **Built on SOAP-RPC**

WS Security Standards

- **Examples**
  - **XML Signature**
  - **XML Encryption**
  - **XML Key Management Specification (XKMS)**
  - **XML Access Control Language (XACL)**
  - **Security Assertion Markup Language (SAML)**
  - **Project Liberty**
- **Can do none of it and rely on TLS/SSL**
  - **Encrypt everything**

WS Security Standards

- **Relationships of standards**



WS Security Standards

- **XML Signature**
  - **Allows digitial signature for whole or partial XML document**
  - **Processes for signature validation**
  - **<Signature> element added to SOAP header**
  - **Types**
    - **Enveloped (signs content containing the signature)**
    - **Enveloping (signs an object element of the signature itself)**
    - **Detached (signs content external to the signature)**
  - **`http://www.w3.org/Signature/`**

WS Security Standards

- **Detached signature example**

```
<Signature Id="MyFirstSignature"
    xmlns="http://www.w3.org/2000/09/xmldsig#">
  <SignedInfo>
    <CanonicalizationMethod
        Algorithm="http://www.w3.org/TR/2001/REC-xml-c14n-20010315"/>
    <SignatureMethod Algorithm="http://www.w3.org/2000/09/xmldsig#dsa-
sha1"/>
    <Reference URI="http://some.where.org/content/">
      <DigestMethod Algorithm="http://www.w3.org/2000/09/xmldsig#sha1"/>
      <DigestValue>j6lwx3rvEPO0vKtMup4NbeVu8nk=</DigestValue>
    </Reference>
  </SignedInfo>
  <SignatureValue>MC0CFFrVLtRlk=…</SignatureValue>
  <KeyInfo>
    <KeyValue><DSAKeyValue>…</DSAKeyValue></KeyValue>
  </KeyInfo>
</Signature>
```

WS Security Standards

- **XML Encryption**
  - **Encrypting or decrypting whole or partial XML document or binary data**
  - **References XML Signature specification**
  - **<EncryptedData> element(s) in SOAP body (and header)**
  - **Can encrypt leaf element or element tree**
  - **`http://www.w3.org/Encryption/2001/`**

WS Security Standards

- **XML Encryption example**

```
<PaymentInfo xmlns="http://example.org/paymentv2">
  <Name>John Smith</Name>
  <CreditCard Limit="5,000" Currency="USD">
    <Number>4019 2445 0277 5567</Number>
    <Issuer>Example Bank</Issuer>
    <Expiration>04/02</Expiration>
  </CreditCard>
</PaymentInfo>
```

```
<PaymentInfo xmlns="http://example.org/paymentv2">
  <Name>John Smith</Name>
  <EncryptedData Type="http://www.w3.org/2001/04/xmlenc#Element"
      xmlns="http://www.w3.org/2001/04/xmlenc#'>
    <CipherData>
      <CipherValue>A23B45C56</CipherValue>
    </CipherData>
  </EncryptedData>
</PaymentInfo>
```

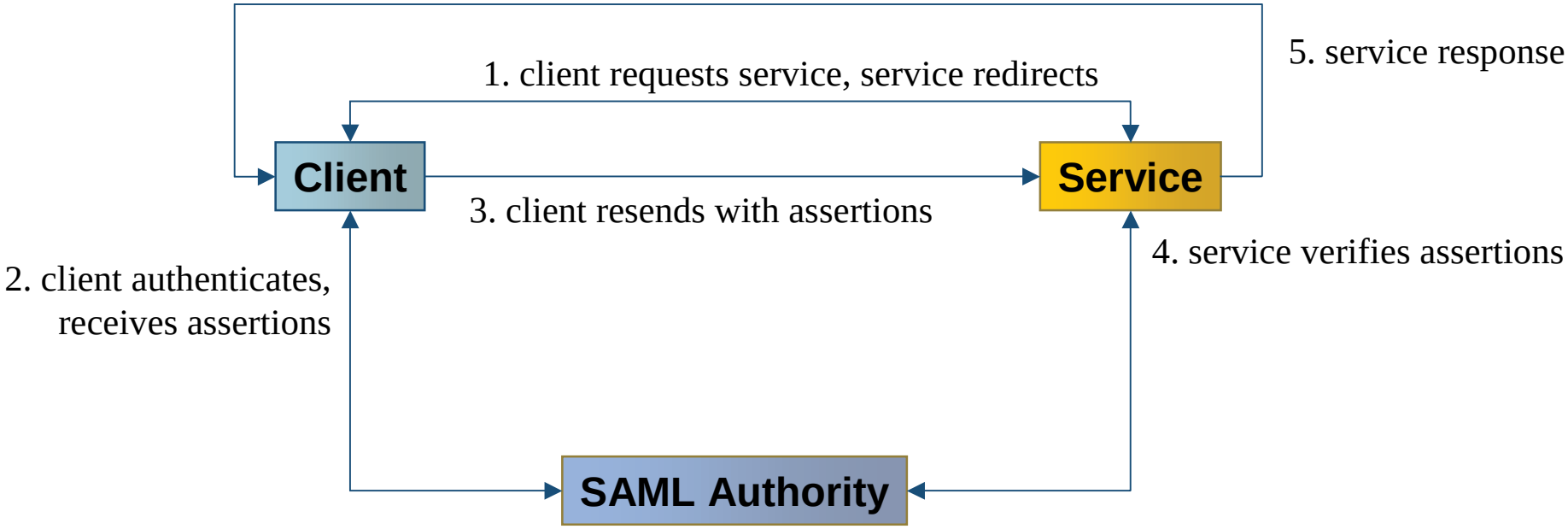
WS Security Standards

- **SAML**
  - **XML framework for exchanging authentication and authorization information**
  - **Assertions handed out by "SAML authorities", themselves web services**

  - `http://www.oasis-open.org/committees/security/`
  - `http://www.opensaml.org`

WS Security Standards

- **SAML scenario**



WS Security Standards

- **Project Liberty**
  - **Uses SAML for single sign-on (SSO)**
  - **Identity Federation Framework (ID-FF)**
    - **Identity/account linkage, SSO, session management**
  - **Identity Service Interface Specification (ID-SIS)**
    - **Schema and specs for interoperable identity services**
  - **Identity Web Services Framework (ID-WSF)**
    - **Framework for identity-based web services**
    - **Includes SOAP binding**
    - **Dynamic discovery of identity services**
    - **SOAP Authorization Service to authenticate parties communicating via SOAP**
  - **`http://www.projectliberty.org`**

Other Technologies

- **JXTA**
  - **Peer-to-peer (P2P) discovery and virtual networking**
  - **Rendezvous peers can forward between firewalls and NAT addressing over HTTP (if firewall allows)**
  - **Collection of protocols**
    - **peer discovery, peer information, peer resolver, pipe binding, endpoint routing, rendezvous**
  - **`http://www.jxta.org`**

Other Technologies

- **Jini**
  - **Adaptive, resilient, network-centric services**
  - **Based on Java, requires Java proxies**
  - **Code mobility**
  - **JavaSpaces “virtual space” Jini service**

  - **http://www.jini.org**
  - **http://java.sun.com/products/jini/**
  - **http://java.sun.com/products/javaspaces/**

Specifications Related to SensorNet

- **OpenGIS SensorWeb**
  - **Sensor Modeling Language (SensorML)**
  - **Sensor Collection Service**
  - **`http://ip.opengis.org/swe`**