Ontology Summit 2015
Internet of Things

ISO/IEC/IEEE P21451-1-4 XMPP Interface for Smart Transducers and the 1st International Semantic Web 3.0 Standard for the Internet of Things

Sensei/IoT* XMPP

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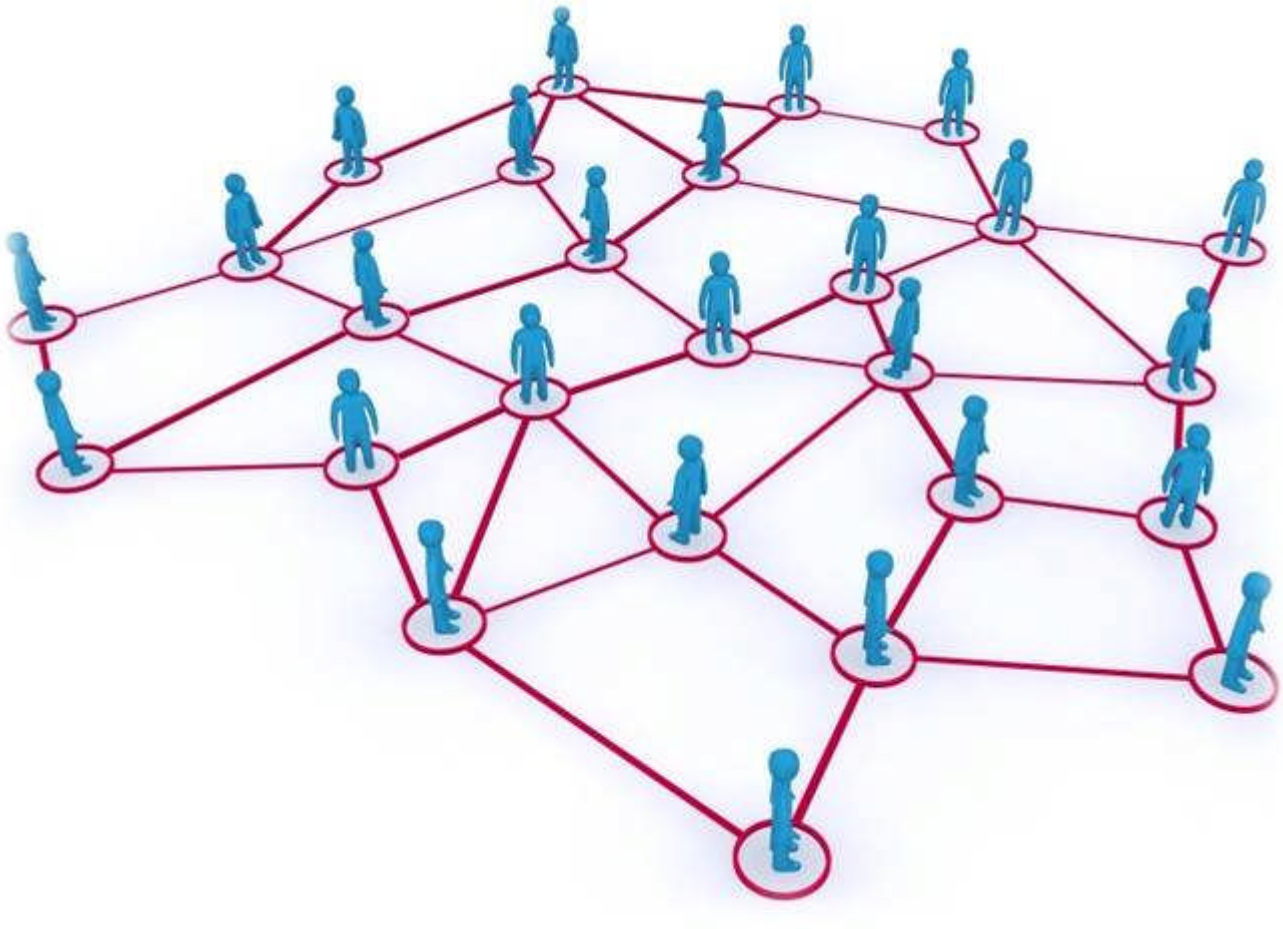
Chairman

January 22, 2015

Internet of Things (IoT)

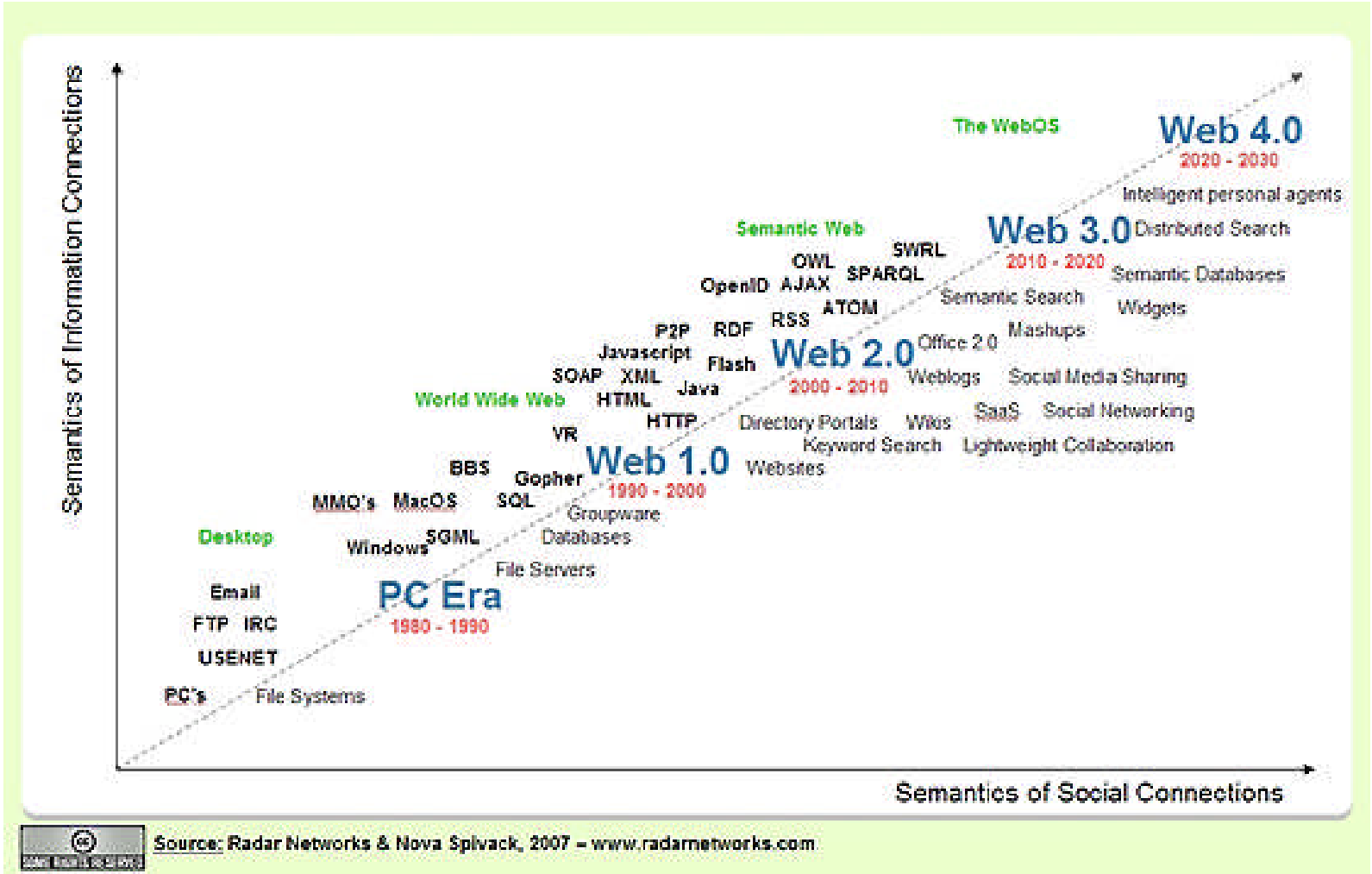
Social Networking Driving the Evolution of the Internet



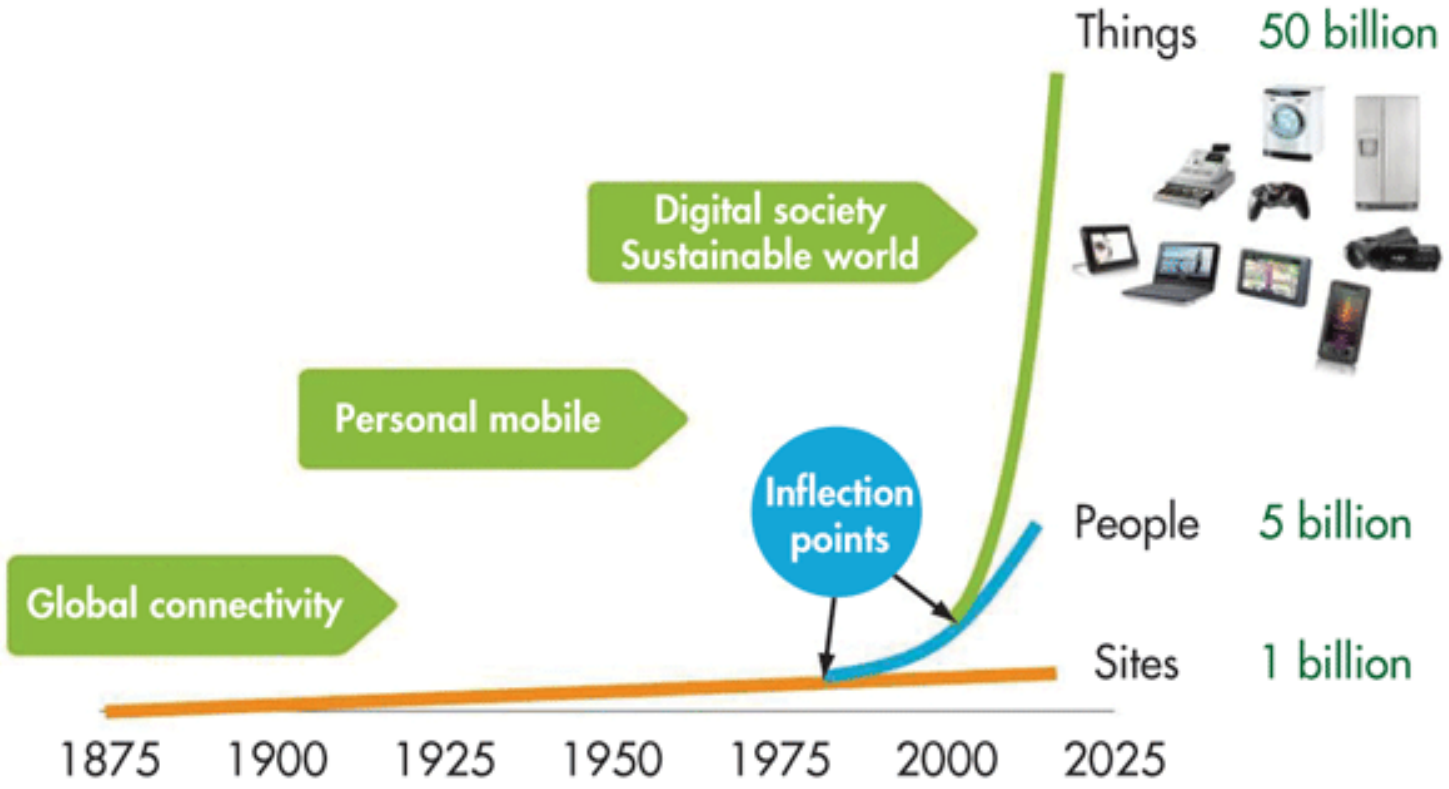
Social Media and Presentation/Virtual Conferencing Providers

- Facebook
- Twitter
- GoogleTalk
- MSN
- GotoMeeting
- WebEx
- Skype
- Yahoo

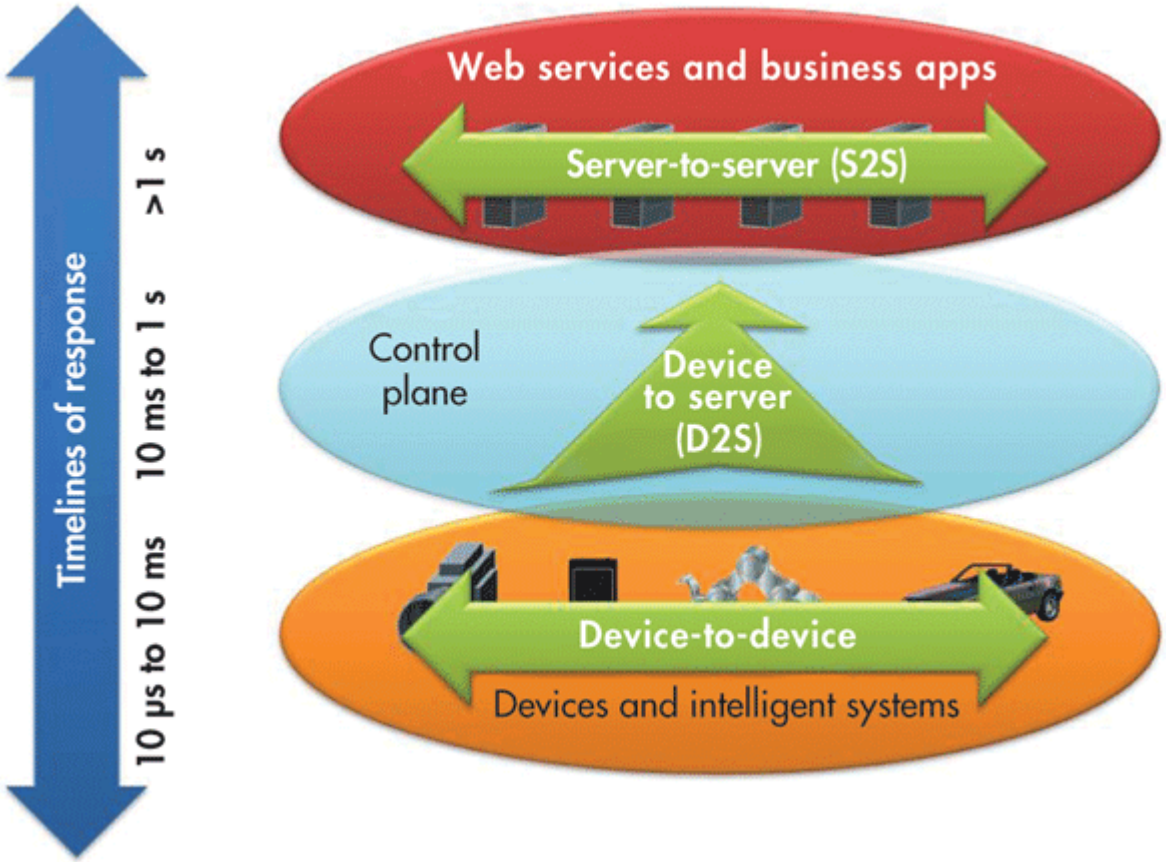
Semantic Web 3.0



IoT Timeline



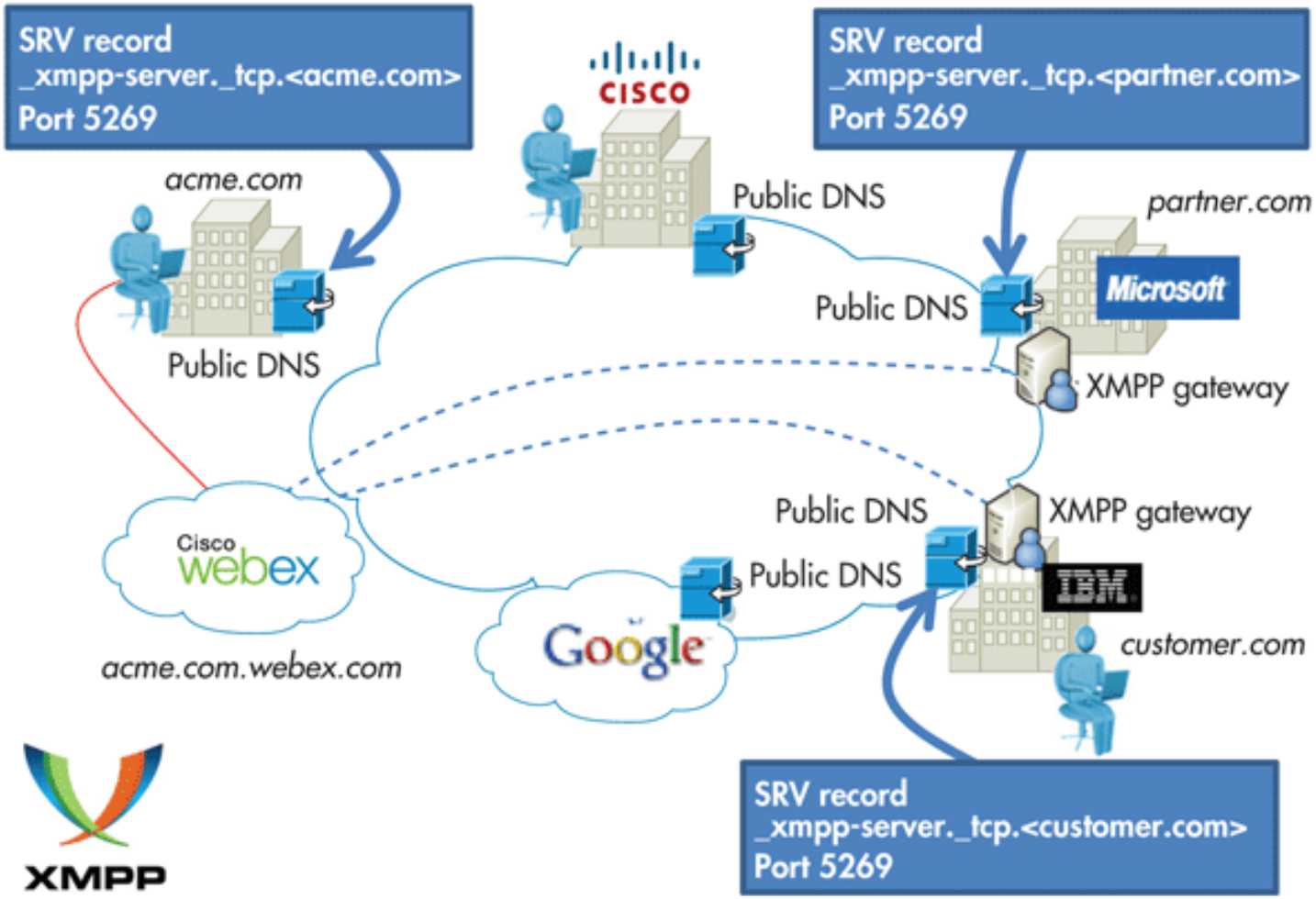
IoT Response Times



IoT Protocols and Standards

- XMPP – (XSF, IETF, W3C, ISO, IEC, IEEE, uPnP) eXtensible Messaging and Presence Protocol
- MQTT – (OASIS)
  - Message Queuing Telemetry Transport
- REST – (W3C)
  - Representational State Transfer
- CoAP – (IETF)
  - Constrained Application Protocol

XMPP


SRV record
_xmpp-server._tcp.<acme.com>
Port 5269
SRV record
_xmpp-server._tcp.<partner.com>
Port 5269
CISCO
acme.com
Public DNS
Public DNS
partner.com
Microsoft
Public DNS
XMPP gateway
Cisco
webex
acme.com.webex.com
Public DNS
XMPP gateway
Public DNS
Google
IBM
customer.com
SRV record
_xmpp-server._tcp.<customer.com>
Port 5269
XMPP

ISO/IEC/IEEE P21451-1-4

XMPP Interface Standard for Smart Transducers

(Sensei-IoT*)

http://www.sensei-iot.org

2013 to 2015

ISO/IEC/IEEE P21451-1-4

- *"**Sensei-IoT***" is the first joint effort between ISO, IEC, and IEEE, known as P21451-1-4 XMPP Interface for Smart Transducers and the 1st Semantic Web 3.0 Standard for the Internet of Things (IoT).*

- *Hosted by Dr. Kang Lee, Chairman of IEEE TC-9 Sensor Technology, and Dan Kimball, SRA, Chairman of ISO JTC1/SC31 Automatic Identification/Data Capture and WG4 Internet of Things (IoT)*

Universal Unique Identifier (UUID)

- **ISO/IEC/IEEE P21451-1-4** will use a JID (Jabber Identifier) (EUI-64) which is a Universal Unique IDentifier (UUID), defined in ISO/IEC 29161 Automatic Identification for the Internet of Things developed by ISO JTC1/ SG31 WG2 Automatic Identification & Data Capture and WG4 Internet of Things (IoT).
- JID = [node “@”] domain [“/” resource {device}]

- Ex: QR Code 

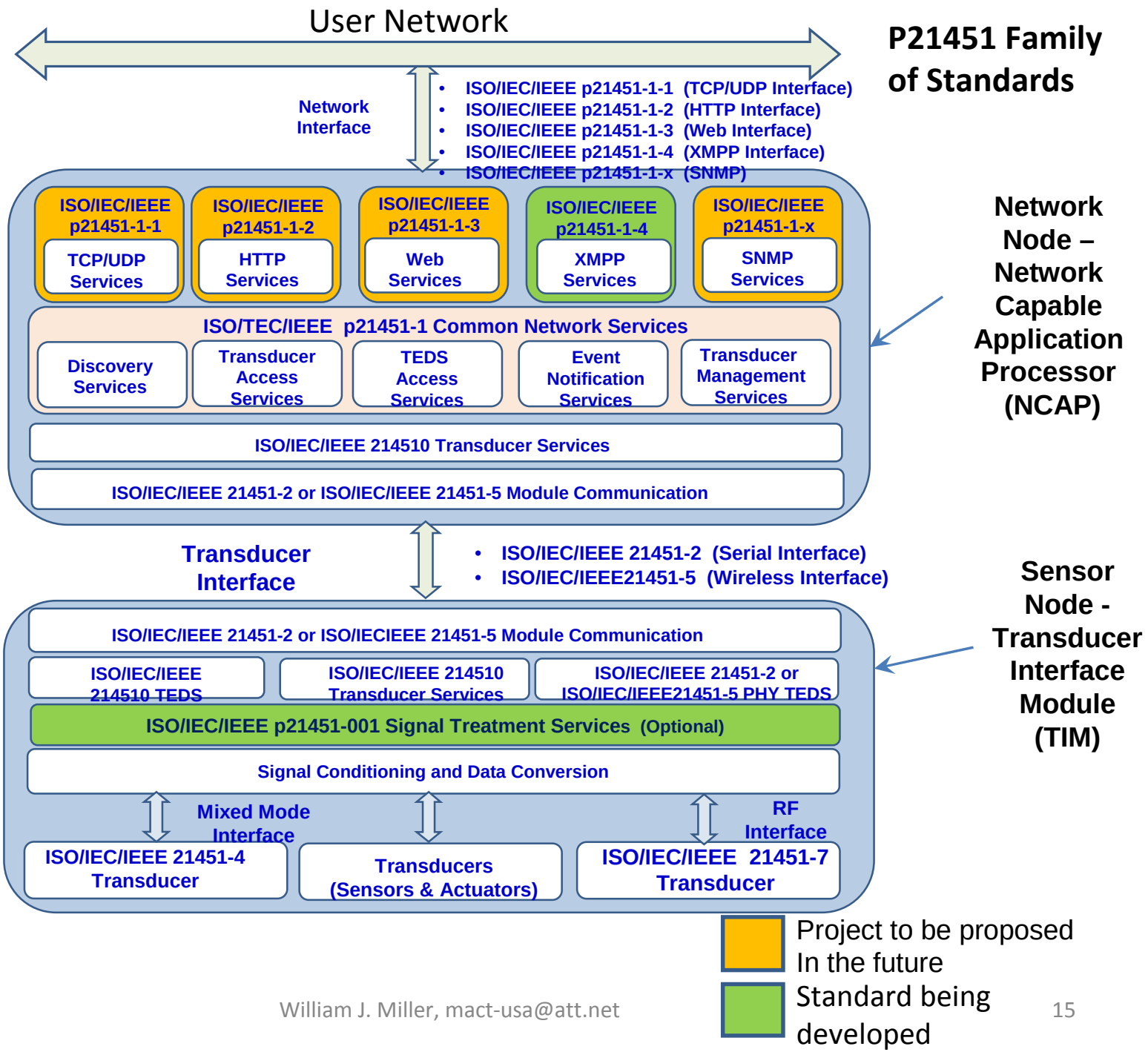
IoT XEP's (XMPP Extensions)

- XEP-0322-SN Efficient XML Interchange (EXI) Format
- XEP-0000-SN Battery Powered Sensors
- XEP-0326-SN-Concentrators
- XEP-0325-SN-Control
- XEP-0000-SN-Discovery
- XEP-0000-SN-Events
- XEP-0000-SN-Interoperability (In-Process)
- XEP-0324-SN-Provisioning
- XEP-0000-SN-PubSub
- XEP-0323-SN-SensorData
- XEP-0332-SN-HTTP over XMPP

NOTE – "XEP-0000" are pending by XSF

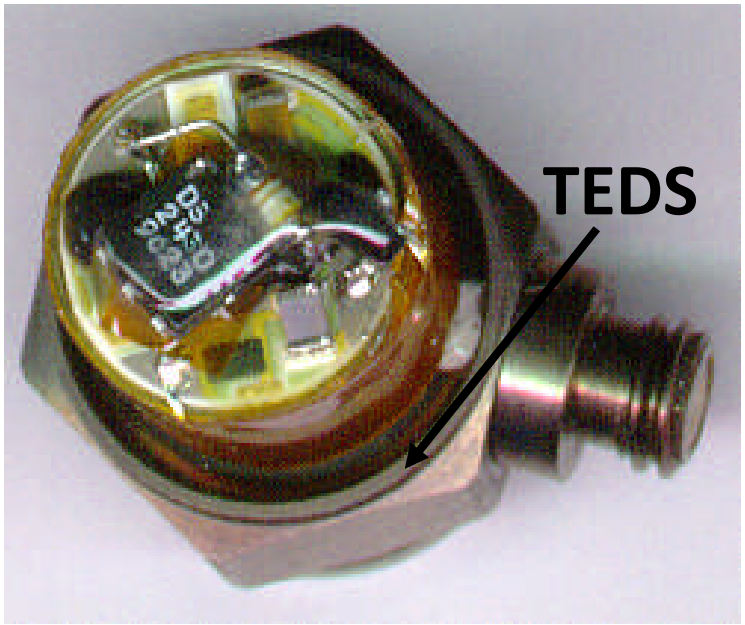
The 21451 Smart Transducer Standard
Key Features of
Smart Transducers (Sensors/Actuators)

- Self-identification and self-description
- Self-calibration
- Time-aware
- Location-aware
- Intelligence (e.g. signal processing, data fusion, event notification, ...)
- Ease of measurement - output in terms of physical units (e.g., Kelvin,.)
- Standards-based wired or wireless communications
- Enable ease of connection to systems by simply plug-and-play, hence minimize human intervention, simplify Internet of Things (IoT) ecosystem integration

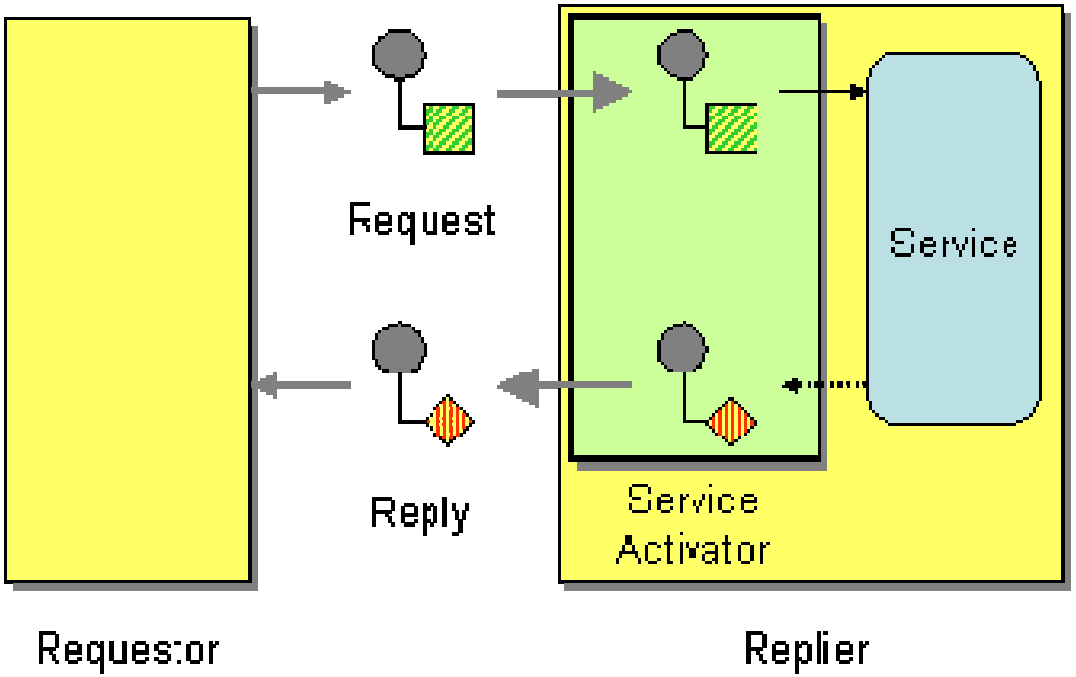

User Network
P21451 Family of Standards
Network Interface
• ISO/IEC/IEEE p21451-1-1 (TCP/UDP Interface)
• ISO/IEC/IEEE p21451-1-2 (HTTP Interface)
• ISO/IEC/IEEE p21451-1-3 (Web Interface)
• ISO/IEC/IEEE p21451-1-4 (XMPP Interface)
• ISO/IEC/IEEE p21451-1-x (SNMP)
ISO/IEC/IEEE p21451-1-1
TCP/UDP Services
ISO/IEC/IEEE p21451-1-2
HTTP Services
ISO/IEC/IEEE p21451-1-3
Web Services
ISO/IEC/IEEE p21451-1-4
XMPP Services
ISO/IEC/IEEE p21451-1-x
SNMP Services
ISO/TEC/IEEE p21451-1 Common Network Services
Discovery Services
Transducer Access Services
TEDS Access Services
Event Notification Services
Transducer Management Services
ISO/IEC/IEEE 214510 Transducer Services
ISO/IEC/IEEE 21451-2 or ISO/IEC/IEEE 21451-5 Module Communication
Network Node – Network Capable Application Processor (NCAP)
Transducer Interface
• ISO/IEC/IEEE 21451-2 (Serial Interface)
• ISO/IEC/IEEE21451-5 (Wireless Interface)
ISO/IEC/IEEE 21451-2 or ISO/IECIEEE 21451-5 Module Communication
ISO/IEC/IEEE 214510 TEDS
ISO/IEC/IEEE 214510 Transducer Services
ISO/IEC/IEEE 21451-2 or ISO/IEC/IEEE21451-5 PHY TEDS
ISO/IEC/IEEE p21451-001 Signal Treatment Services (Optional)
Signal Conditioning and Data Conversion
Mixed Mode Interface
RF Interface
ISO/IEC/IEEE 21451-4 Transducer
Transducers (Sensors & Actuators)
ISO/IEC/IEEE 21451-7 Transducer
Sensor Node - Transducer Interface Module (TIM)
Project to be proposed In the future
Standard being developed

Transducer Electronic Data Sheets (TEDS)

- TEDS, a memory device attached to a smart transducer node, store Metadata, transducer identification, measurement range, calibration, correction data, user and manufacture-related information, which can be used for transducer self-identification and description.
- Different TEDS are defined:
- Meta TEDS
  - Transducer Channel TEDS
  - Physical TEDS
  - Calibration TEDS
  - Frequency Response TEDS
  - Geo-location TEDS
  - and more….



P21451-1-4
XMPP Service (Request/Reply)



P21451-1-4
XMPP Interface

- P21451-1-4 can be used for a gateway, direct I/O, and/or server-to-server.
- P21451-1-4 defines a common language for transport of semantic messaging.
- P21451-1-4 combines instant sensor messaging with presence and built-in security.
- P21451-1-4 offers an approach that is technology agnostic and protocol independent

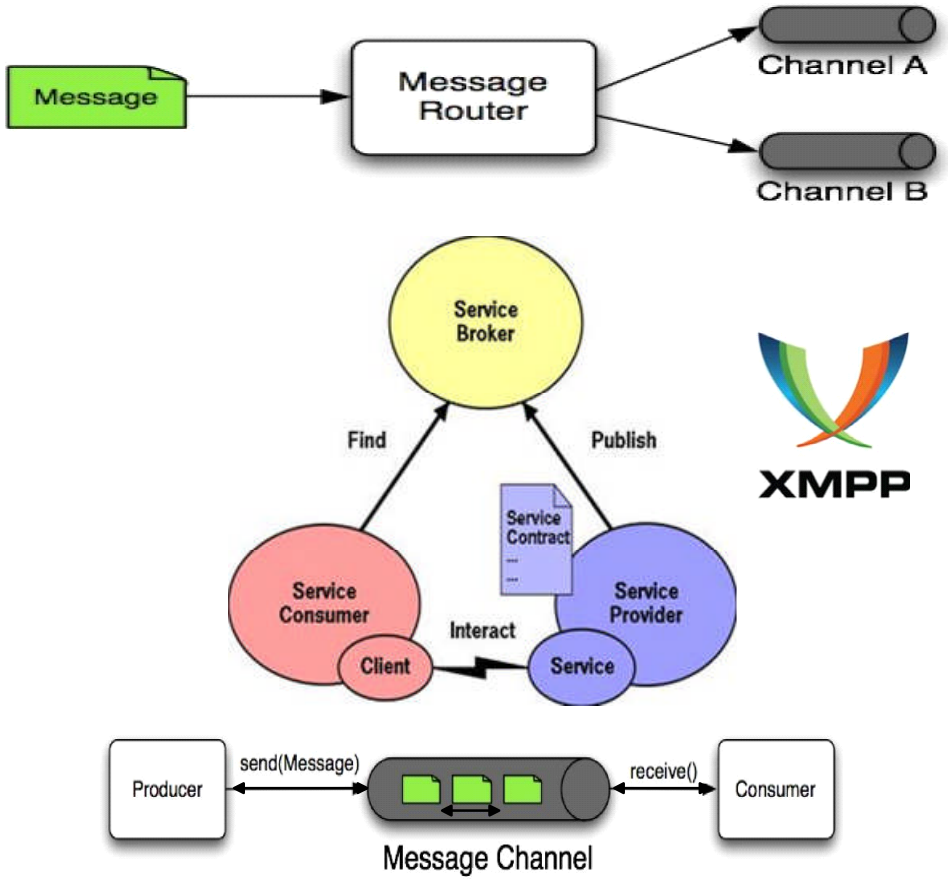
What is XMPP?

- **XMPP Standards Foundation** (**XSF**) is the foundation in charge of the standardization of the protocol extensions of eXtensibile Messaging and Presence Protocol (XMPP), the open standard of instant messaging and presence of the IETF.

IETF XMPP

- IETF XMPP Working Group has already produced a number of documents:
- RFC 3920 – XMPP: Core, which describes client-server messaging using two open-ended XML streams. A connection is authenticated with Simple Authentication and Security Layer (SASL) and encrypted Transport Layer Security (TLS).
- RFC 3921 – XMPP: Instant Messaging and Presence.
- RFC 3922 – Mapping the XMPP to Common Presence and Instant Messaging
- RFC 3923 – End-to-End Signing and Object Encryption for XMPP.
- http://www.xmpp.org/about-xmpp/xsf

Service Oriented Architecture (SOA)

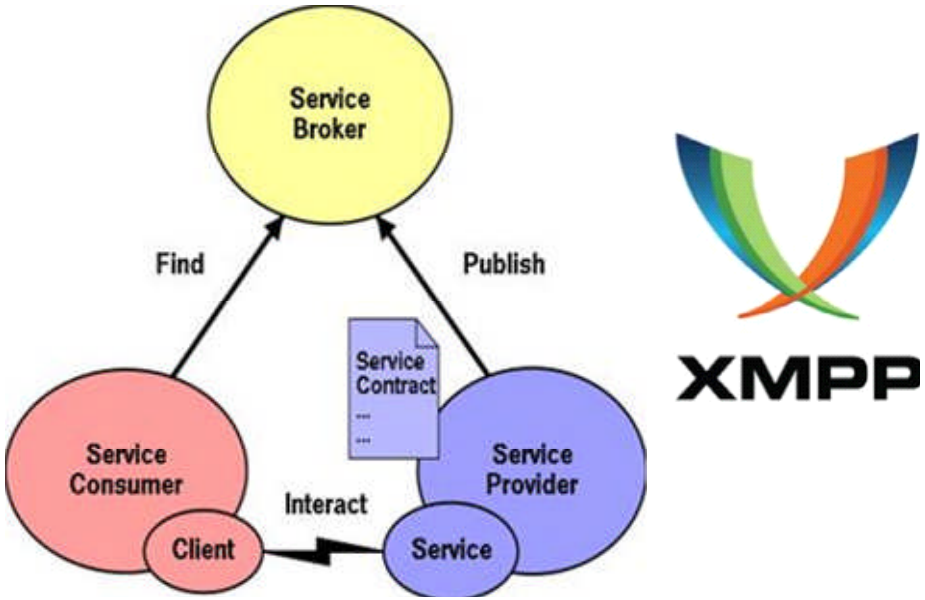


IoT Message Routing

- Unique Identification
- Apply Policy per Flow
- Messages not retained and are forwarded to end-point that are available (Presence)

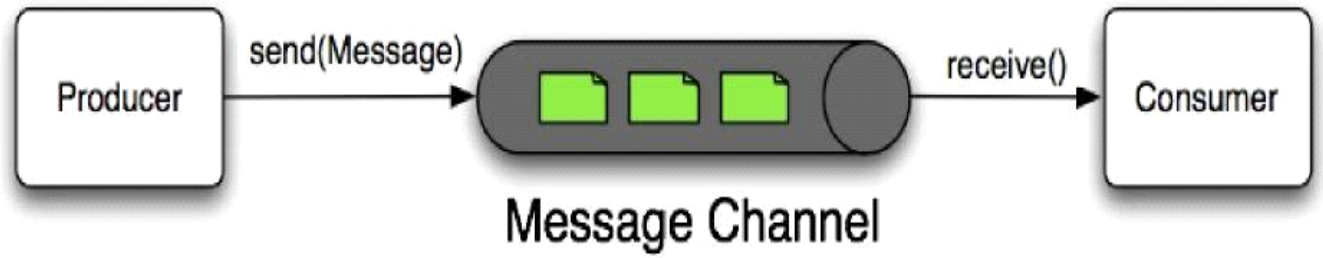
IoT Service Broker

- The Broker directs flows to multiple end-points

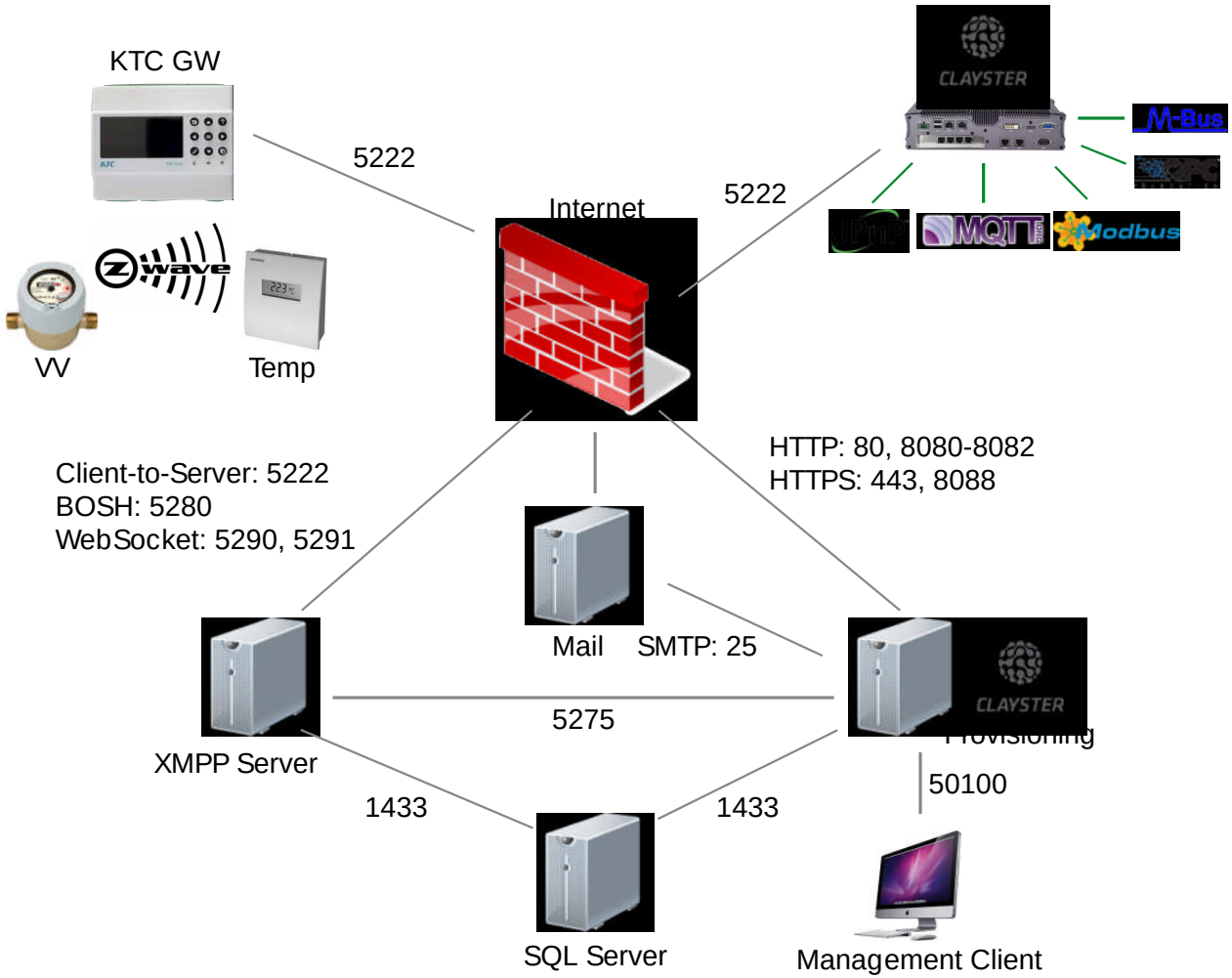


IoT Message Channel

- Messages can be shared with trusted users, devices, and applications in different domains.
- The dialog between the devices uses XMPP as a common language to exchange sensor data



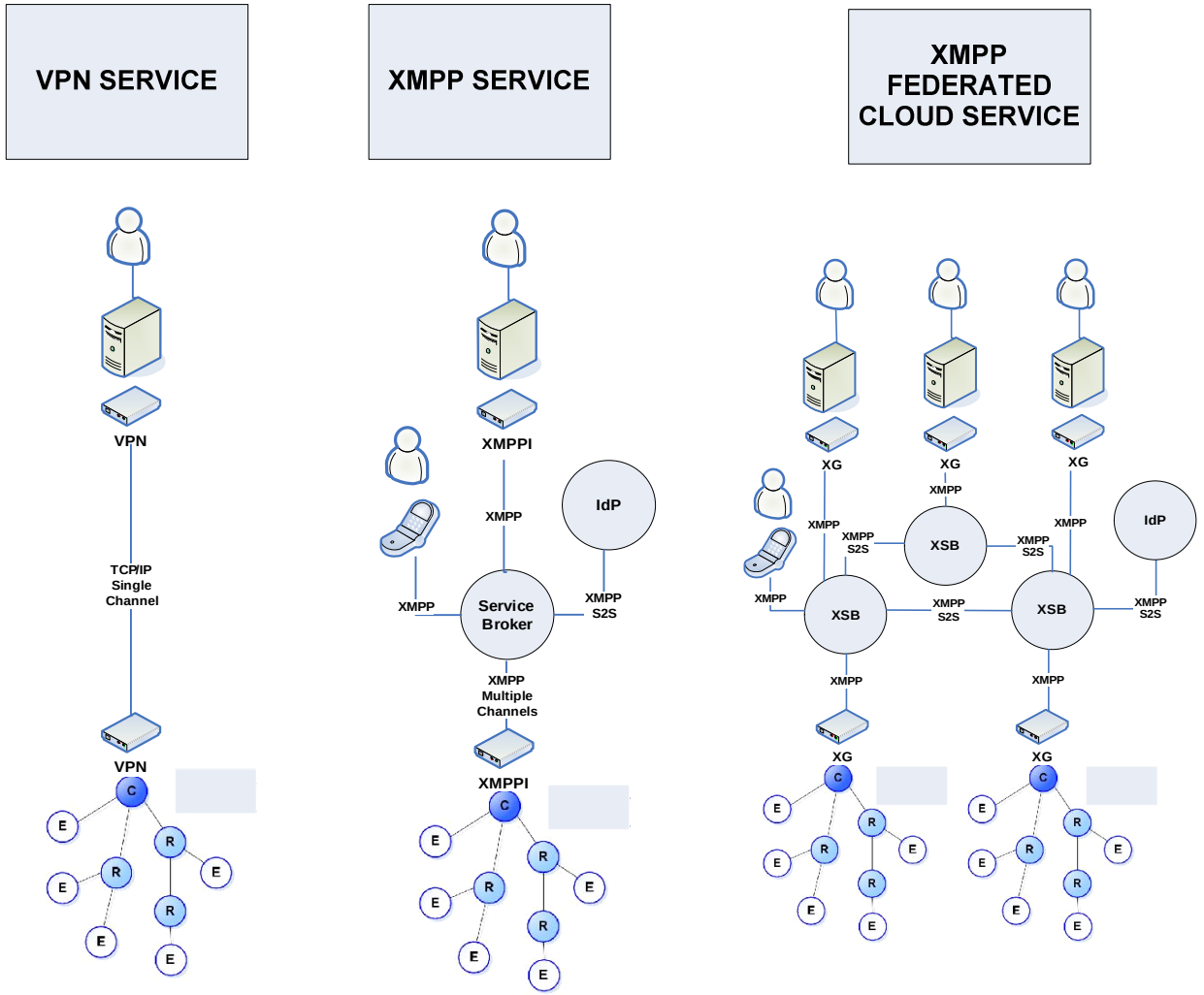
IoT Provisioning

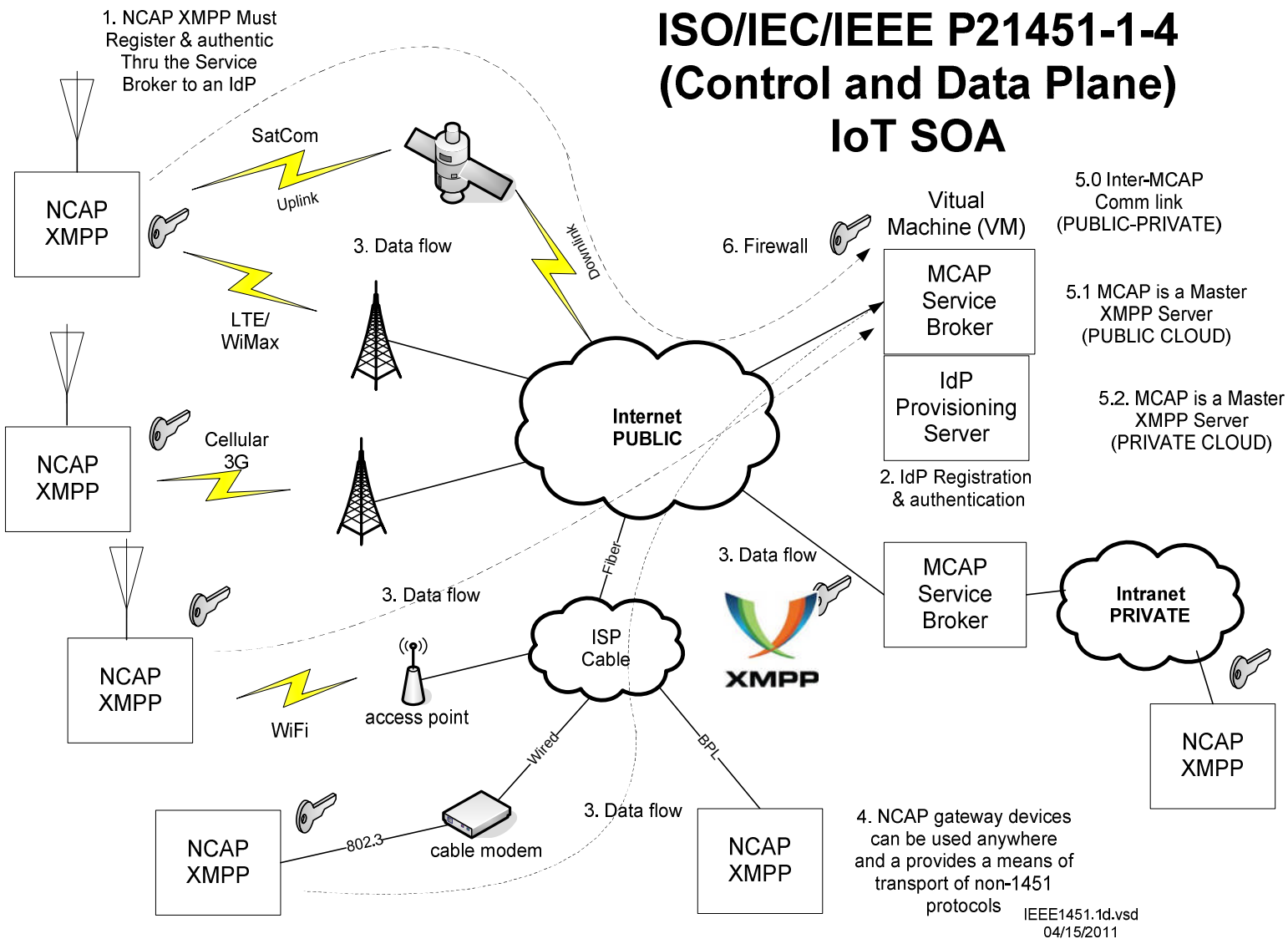


IoT Data Sharing

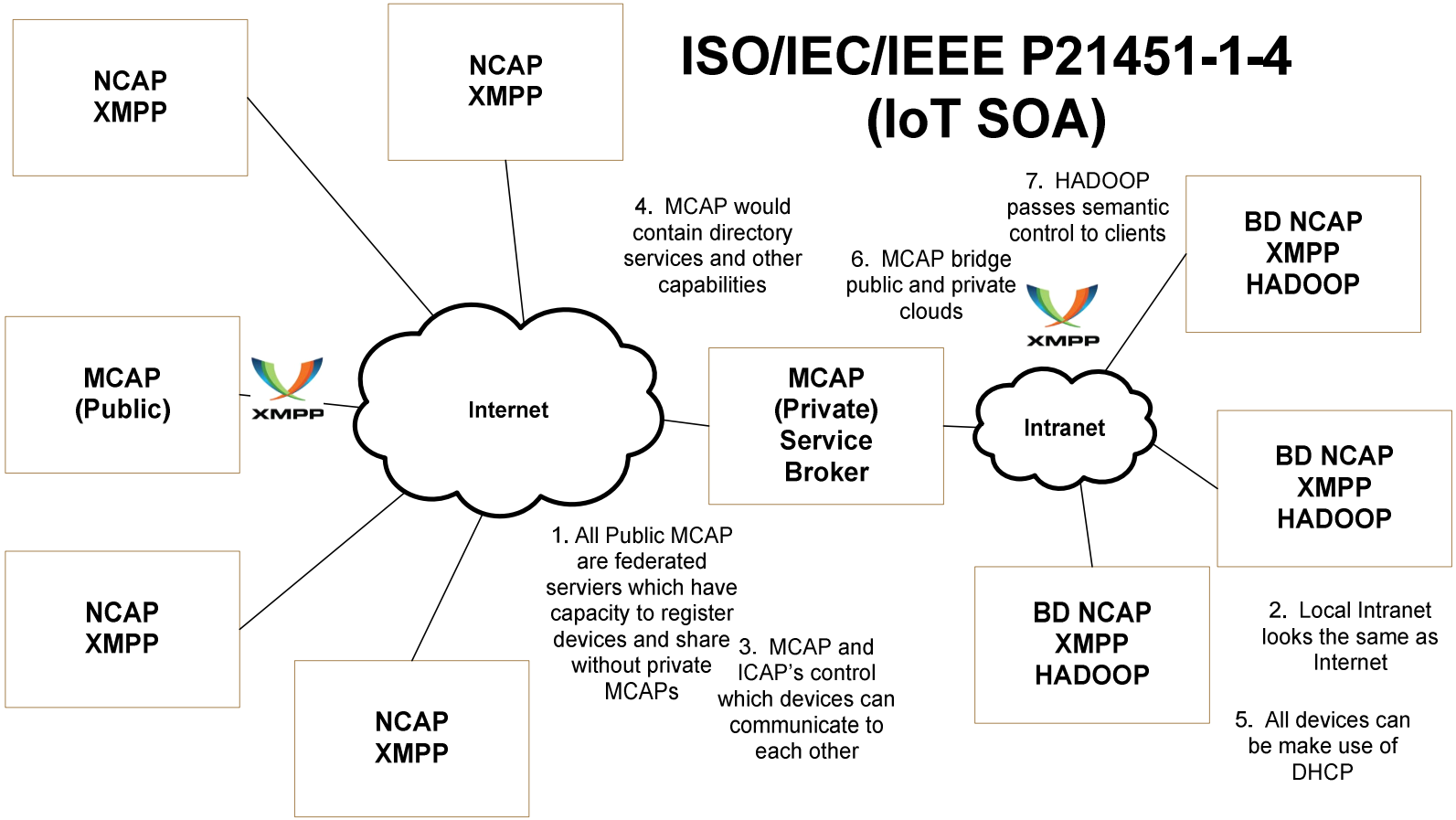
- The XMPP Architectural Framework facilitates sharing resources (i.e. sensors, actuators, data, audio, and/or video)
- Cyber-attacks are minimized by XMPP metadata isolation which includes encryption, device provisioning, and usa of a service broker.
- Sensor data is only available to end points that are trusted and not retained on a central server which would lead to confidentiality concerns.

IoT Scalability



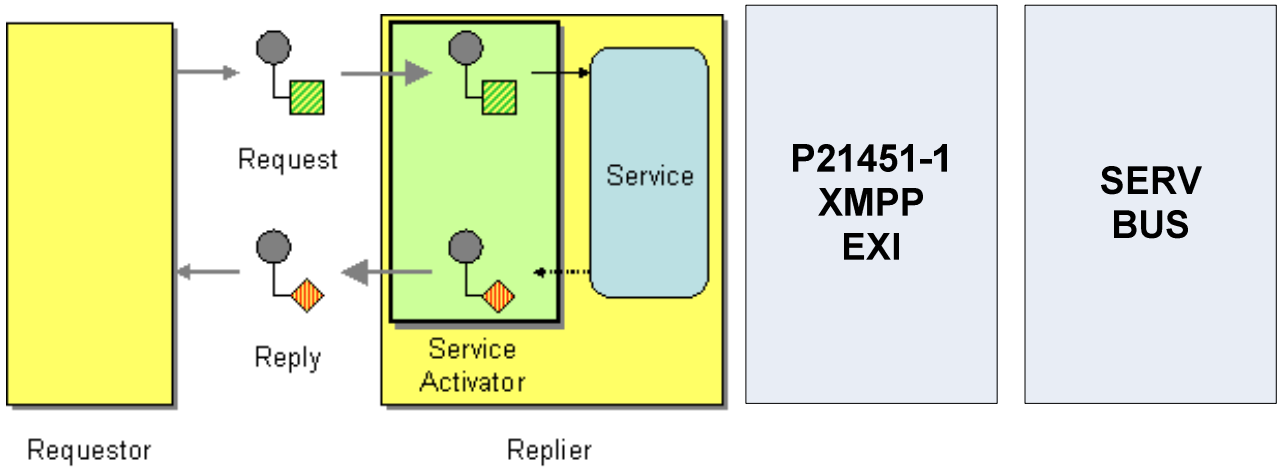

ISO/IEC/IEEE P21451-1-4
(Control and Data Plane)
IoT SOA
1. NCAP XMPP Must Register & authentic Thru the Service Broker to an IdP
NCAP XMPP
SatCom
Uplink
Downlink
3. Data flow
LTE/ WiMax
Cellular 3G
NCAP XMPP
NCAP XMPP
3. Data flow
WiFi
access point
Internet PUBLIC
Fiber
ISP Cable
Wired
BPL
NCAP XMPP
802.3
cable modem
3. Data flow
NCAP XMPP
6. Firewall
Vitual Machine (VM)
MCAP Service Broker
IdP Provisioning Server
2. IdP Registration & authentication
5.0 Inter-MCAP Comm link (PUBLIC-PRIVATE)
5.1 MCAP is a Master XMPP Server (PUBLIC CLOUD)
5.2. MCAP is a Master XMPP Server (PRIVATE CLOUD)
3. Data flow
XMPP
MCAP Service Broker
Intranet PRIVATE
NCAP XMPP
4. NCAP gateway devices can be used anywhere and a provides a means of transport of non-1451 protocols
IEEE1451.1d.vsd
04/15/2011

ISO/IEC/IEEE P21451-1-4 (IoT SOA)

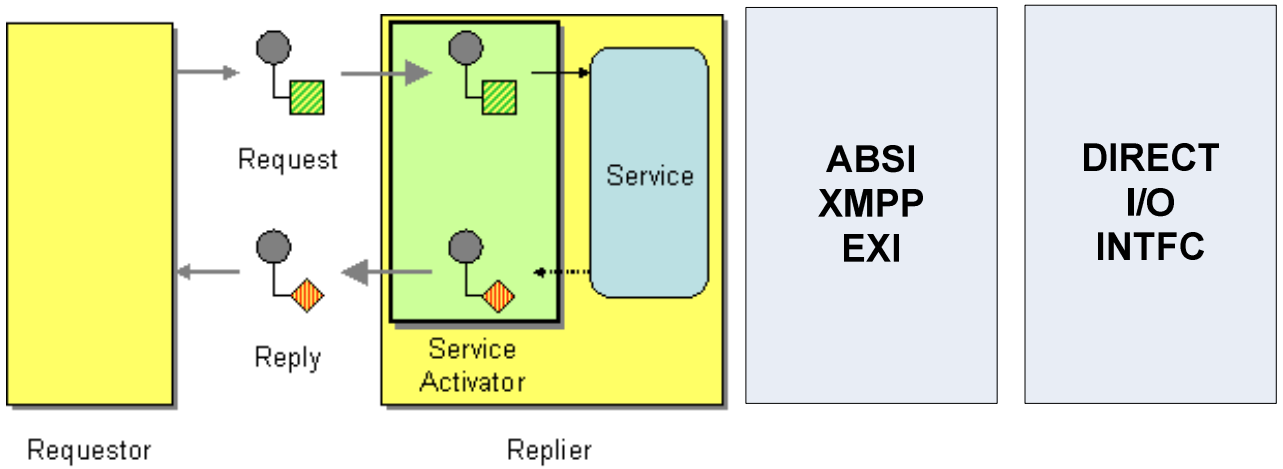


P21451-1-4
Abstract Services

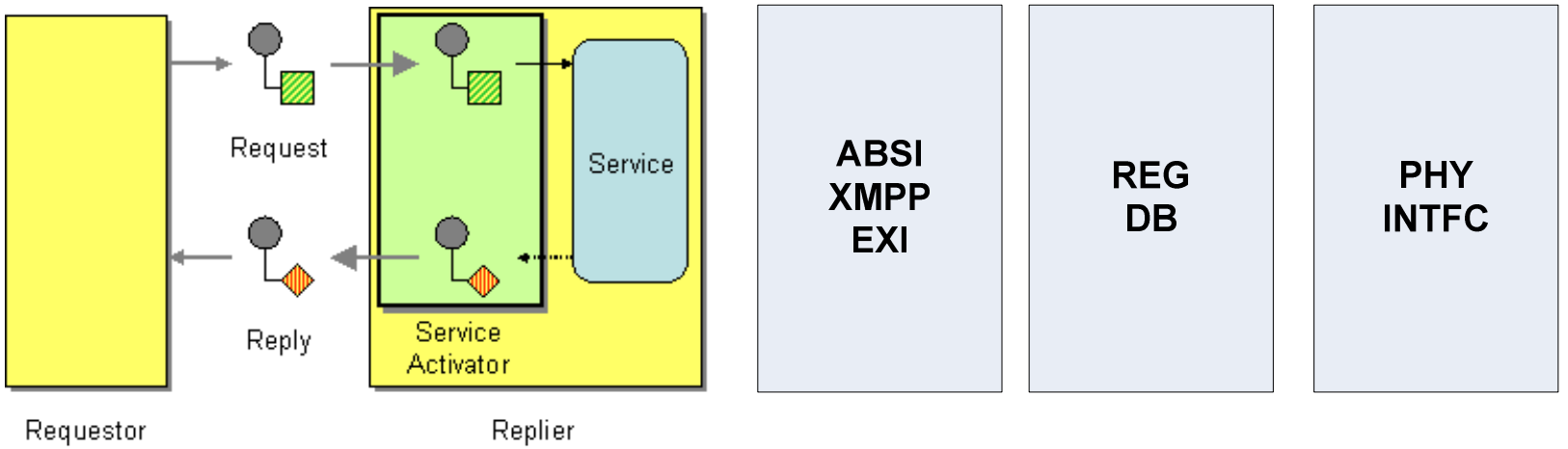
P21451-1-4 Abstract Service 1 (Gateway)



P21451-1-4 Abstract Service 2 (Direct I/O)



P21451-1-4 Abstract Service 3 (Concentrator)



P21451-1-4
Requests/Responses

XMPP Message Structure (Stream Attributes)

- iq type – identifies the command exchange
- From= where message is sent from
- To= where message is to be delivered
- Id= identification for this item (important for iq)
- Message Stanza: <isFriend **xmins='urn:xmpp:iot:provisioning'jid="client1@clayster.com**/>
- The full message:

<**iq type='get'**
from='device@clayster.com/device'
to='provisioning.clayster.com'
id='9'>
<**isFriend xmlns**='urn:xmpp:iot:provisioning'
jid='client1@clayster.com'/>
</**iq**

http://http://xmpp.org/rfcs/rfc3920.html

IoT Discovery (Request)

- The following retries a list of Resources with this message}
- <**iq type**=’get’
  from=’requester@example.org’
  to=’responder@example.org’
  id=’info1>
  <**query** xmlns=’https://jabber.org/protocol/disco#info>
  <**identity** category’gateway’ type=’ncap name=’ncapid’/>
  <feature var=’urn:xmpp:iot:interoperability'/> REQ’D
  <feature var=’urn:xmpp:iot:sensordata'/> OPT
  <feature var=’urn:xmpp:iot:control'/> OPT
  <feature var=’urn:xmpp:iot:concentrators'/> OPT
  <feature var=’http://jabber.org/protocol/disco#info’/>
  <feature var=’http://jabber.org/protocol/disco#items’/>
  <**identity**>
  </guery>
  </**iq**>

IoT Discovery (Reply)

- The Responder provides the following response message

  <**iq type**=’result’

  from=’responder@example.org’

  to=’requester@example.org’

  <**accepted** xmins=‘urn:xmpp:iot:interoperability'

  <**iq type**

IoT Discovery (Reply)

- The Responder provides the following response message

  <**iq type**=’result’

  from=’responder@example.org’

  to=’requester@example.org’

  <**accepted** xmins=‘urn:xmpp:iot:interoperability'

  <**iq type**

IoT Interoperability (Request)

- <**iq type**='get'
  from=’requester@example.org’
  to=’responder@example.org
  id='1'>
  <**getInterfaces** xmlns='urn:xmpp:sn:interoperability'/>
  </**iq**>

The ‘Get’ IoT Interoprabilty Request for 21451 would obtain information from a TEDS (Transducer Electronic Data Sheet)

IoT Interoperability (Reply)

- <**getInterfacesResponse** xmlns='urn:xmpp:sn:interoperability'>
  <interface name='XMPP.IoT.Sensor.DewPoint'/>
  <interface name='XMPP.IoT.Sensor.RainRate'/>
  <interface name='XMPP.IoT.Sensor.WindDirection'/>
  <interface name='XMPP.IoT.Sensor.WindSpeed'/>
  <interface name='XMPP.IoT.Sensor.Humidity'/>
  <interface name='XMPP.IoT.Sensor.SolarRadiation'/>
  <interface name='XMPP.IoT.Sensor.Temperature'/>
  <interface name='XMPP.IoT.Sensor.DewPoint.History'/>
  <interface name='XMPP.IoT.Sensor.RainRate.History'/>
  <interface name='XMPP.IoT.Sensor.WindDirection.History'/>
  <interface name='XMPP.IoT.Sensor.WindSpeed.History'/>
  <interface name='XMPP.IoT.Sensor.Humidity.History'/>
  <interface name='XMPP.IoT.Sensor.SolarRadiation.History'/>
  <interface name='XMPP.IoT.Sensor.Temperature.History'/>
  <interface name='XMPP.IoT.Identity.Clock'/>
  <interface name='XMPP.IoT.Identity.Location'/>
  <interface name='XMPP.IoT.Identity.Manufacturer'/>
  <interface name='XMPP.IoT.Identity.Name'/>
  <interface name='XMPP.IoT.Identity.Version'/>
  <interface name='XMPP.IoT.Media.Camera'/>
  </**getInterfacesResponse**>
</**iq**>

TEDS to XEP-0323.xslt

Meta-identification TEDS

- Transformation using “TEDS to XEP-0323.xslt”:
- Transformed into IoT data according to XEP-0323.

```
<fields seqnr="%SEQNR%" xmlns="urn:xmpp:iot:sensordata">
  <node nodeId="%NODE%">
    <timestamp value="2013-06-04T14:04:31">
      <boolean name="TEDS, Meta identification" value="true" identity="true" />
      <string name="Manufacturer" value="Acme Corp." identity="true" />
      <string name="Model Number" value="1036Z" identity="true" />
      <string name="Product Description" value="4 Channnel Temperature TIM" identity="true" />
      <string name="Serial Number" value="SNAB64" identity="true" />
      <string name="Version" value="V1.30" identity="true" />
      <dateTime name="Date" identity="true" value="2006-05-09T00:00:00" />
    </timestamp>
  </node>
</fields>
```

CLAYSTER

IoT Interoperability for 21451 devices

XML Translation via XSLT
is important to maintain W3C
conformance and future maintainability
with a structured format

IoT Provisioning

- XEP Provisioning offers a means to register a Thing which may be a user, device, or application.
- The Thing is registered via its JID (Jabber Identifier) it must be claimed by the owner.
- The owner decides how the device will be shared.
- The owner can view Thing lists that may be in difference domains, update the registration, or remove a Thing from service.
- The Thing can be provisioned as public or private.
- Mutual trust is assured by agreement to share data.
- Ref. XEP-0323

IoT Sensor Data

- This XEP provides the underlying architecture, basic operations and data structures for sensor data communication over XMPP networks. It includes a hardware abstraction model, removing any technical detail implemented in underlying technologies.
- These XEP's are designed for implementation in sensors, many of which have very limited amount of memory (both RAM and ROM) or resources (processing power). Simplicity is of utmost importance.
- XMPP can easily accessing millions of devices in peer-to-peer sensor networks.
- Ref. XEP-0323

IoT Sensordata
(Message Reply)

- <**message**
  from=’responder@example.org’
  to=’requester@example.org’ >
  <**fields** xmlns='urn:xmpp:iot:sensordata' seqnr='1' done='true**'>**
  <node nodeId=‘Device01'>
  <timestamp value='2013-03-07T16:24:30'>
  <string name='...ID' identity='true' automaticReadout='true' value='1234567'/>
  </timestamp>
  </node>
  </**fields**>
  </**message**>

IoT Control

- Actuators are devices in sensor networks that can be controlled through the network and act with the outside world.
- In sensor networks and Internet of Things applications, actuators make it possible to automate real-world processes.
- Actuators can be controlled in XMPP-based sensor networks, making it possible to integrate sensors and actuators of different brands, makes and models into larger Internet of Things applications.

IoT Concentrator

- Concentrators are devices in sensor networks, concentrating the management of a subset of devices to one point.
- They can be
  - small (eg. PLC:s managing a small set of sensors and actuators),
  - medium-sized (eg. mid-level concentrators, controlling branches of the network, islands, perhaps using separate communication protocols),
  - large (eg. entire sub-systems, perhaps managed by a separate child/partner organization) to massive (eg. The entire top-level system, smart-grid, IoT network).

  Ref. XEP-0326

Sensor Harmonization

- XEP Concentrator allows small, mid-size, and large sensor networks to be unified and exchange sensor information such as MQTT, CoAP, REST, & OPC UA
- XEP Concentrator and XEP Interoperability provide assurance that the end point provides interoperable data which may include manufacturer, owner, engineering units and logic state idescriptors and other relevent information.
- Information can now be shared to a database application and used with data analytics without additional system configuration.

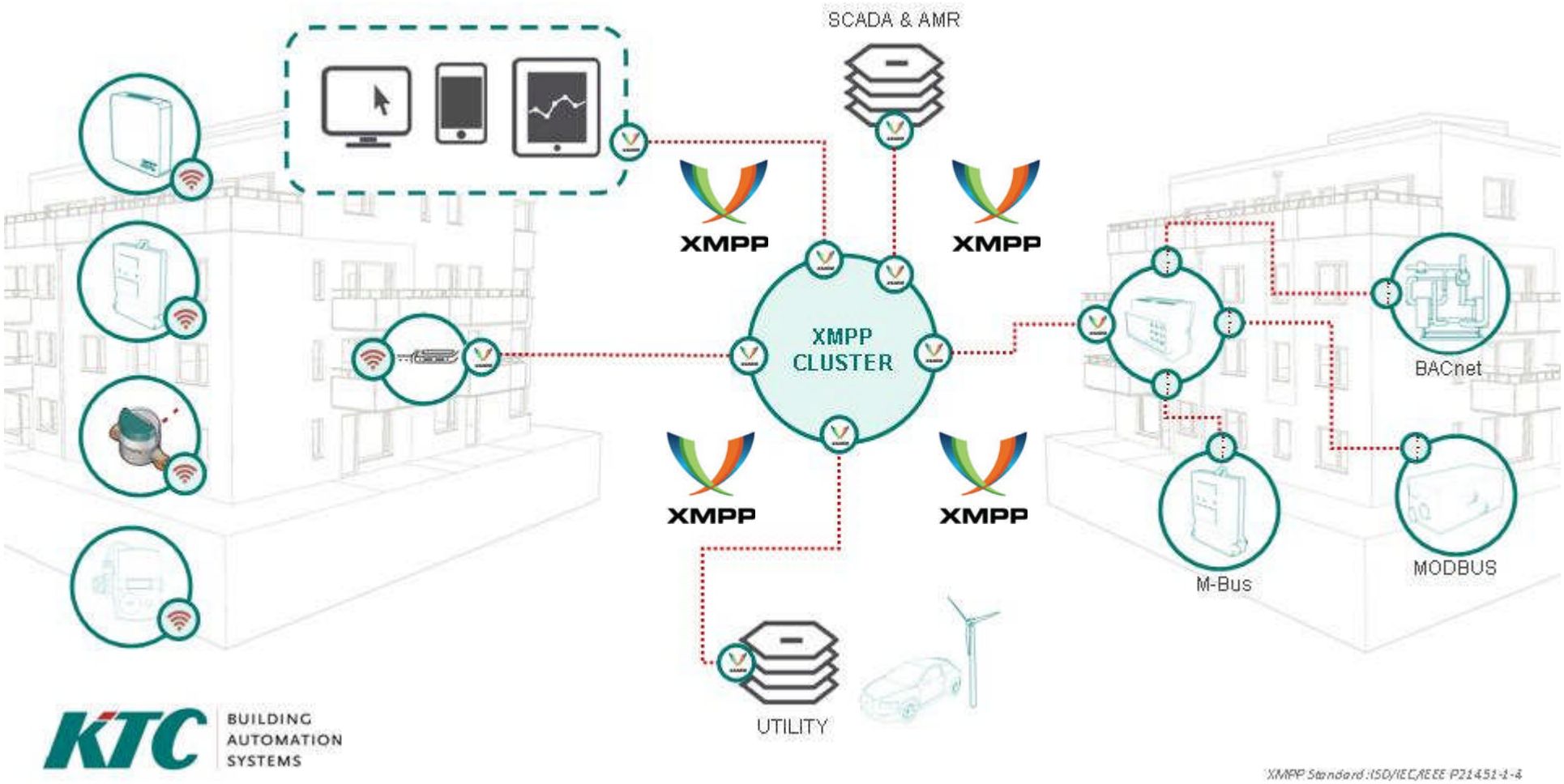
New URI (Uniform Resource Identifier)

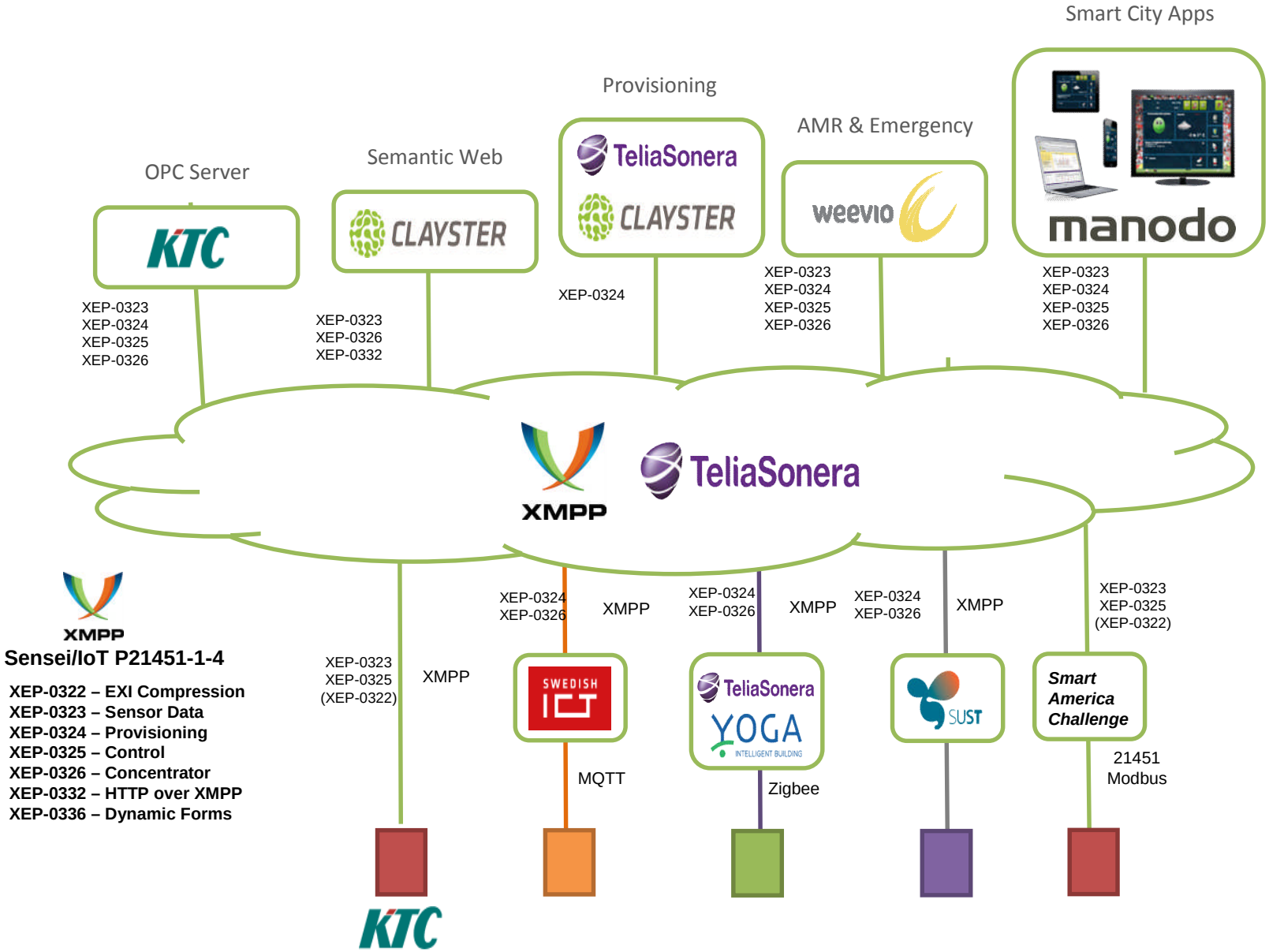
- **HTTP over XMPP** and **EXI** (Efficient XML Interchange) will be used to transport HTTP traffic via a new URI.
- **Ex. httpx://www.xmpp.org**
- **HTTPX** will establish a secure XMPP session with a Service Broker where a device, user, or application can exchange information with anyone who is registered and authorized to share information.
- Ref. XEP-0332

EXI (Efficient XML Interchange)

- **EXI** is a Binary XML format which was adopted as a recommendation by the World Wide Web Consortium (W3C) in March 2011.
- It was developed by the W3C's Efficient XML Interchange and is one of the most prominent binary XML efforts to encode XML in a binary data format, rather than plain text.
- EXI can use any data compressor .
- Ref: XEP-0322

XMPP National Standard (Sweden)




Smart City Apps
Provisioning
AMR & Emergency
OPC Server
Semantic Web
TeliaSonera
CLAYSTER
weevio
manodo
KTC
CLAYSTER
XEP-0323
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XEP-0325
XEP-0326
XEP-0323
XEP-0326
XEP-0332
XEP-0324
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XEP-0326
XEP-0323
XEP-0324
XEP-0325
XEP-0326
XMPP
TeliaSonera
XMPP
Sensei/IoT P21451-1-4
XEP-0322 – EXI Compression
XEP-0323 – Sensor Data
XEP-0324 – Provisioning
XEP-0325 – Control
XEP-0326 – Concentrator
XEP-0332 – HTTP over XMPP
XEP-0336 – Dynamic Forms
XEP-0323
XEP-0325
(XEP-0322)
XMPP
XEP-0324
XEP-0326
XMPP
XEP-0324
XEP-0326
XMPP
XEP-0324
XEP-0326
XMPP
XEP-0323
XEP-0325
(XEP-0322)
SWEDISH ICT
TeliaSonera
YOGA
INTELLIGENT BUILDING
SUST
Smart America Challenge
MQTT
Zigbee
21451
Modbus
KTC

IPDX.NET UNIVERSE
Collaborative Research Network

- ISO/IEC/IEEE P21451-1-4 provides secure session initiation and protocol transport for sensors, actuators, and devices. The standard addresses issues of security, scalability, and interoperability. This standard can provide significant cost savings and reduce complexity, leveraging current instrumentation and legacy devices used in industry.

  http://www.ipdx.net

Sensei/IoT* XMPP

ISO IEC IEEE dvancing Technology for Humanity

Thank you

Questions?

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