**PTC® Live** Global

## PTC 227 - Internet of Things (IoT) Connectivity

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## The Key Challenge of Connectivity in the Internet of Things

"An underground coal miner is not a cow."

JOYGLOBAL

VITAL
HERD, INC

## What is a Device?

A Modem?

A Cellular Router?

A Manufacturing Factory?

A Chicken Coop?

A Smart Pill Dispenser?

A Coal Mining Machine?

Sensors on iDigi/Exosite/Device Cloud Du Jour?

All of the Above?

None of the Above?

## Sources of Device Data & Interaction

| Source | Comments | Solution Options |
|---|---|---|
| Devices/Sensors | 100's of Gateways and Sensor Packages. More appearing every day. Tens of thousands of standalone sensors w/ local connectivity. | ThingWorx SDK, ThingWorx EMS in Gateway, Server Side Protocol Adapters for Industry Standard Protocols (e.g. MQTT, CoAP) |
| OEM Equipment | Unique/Proprietary Protocols to each OEM | Embedded ThingWorx EMS ThingWorx EMS as a Gateway ThingWorx SDK |
| Internet/Web Based Device Clouds | Horizontal and vertical providers. New ones appearing every month | ThingWorx Device Cloud Extensions |
| Intranet / Local Networks | Factory Systems, Building Automation. OSI PI, SCADA, HMI, etc | Direct connection to on-site ThingWorx server, or OPC /EMS based edge solution |

"The nice thing about standards is that there are so many to choose from." *

SMS  OPC  ZigBee/ZWave

HTTP  Device Clouds  Modbus  TCP/UDP

MQTT

CoAP  XMPP  REST

SNMP

Serial/USB

6LoWPAN  BACNET
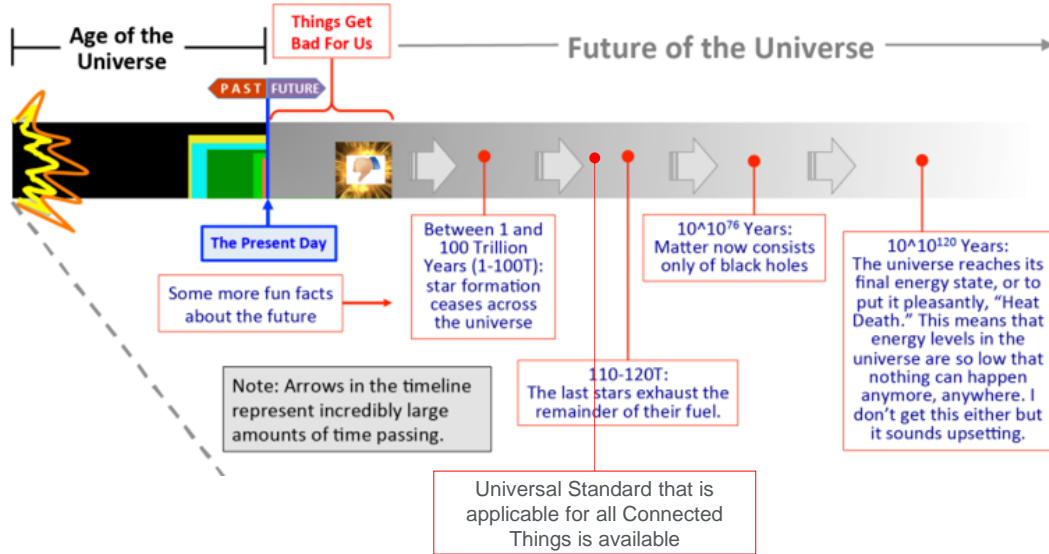
* Andy Tannenbaum - *Computer Networks*, 2nd ed

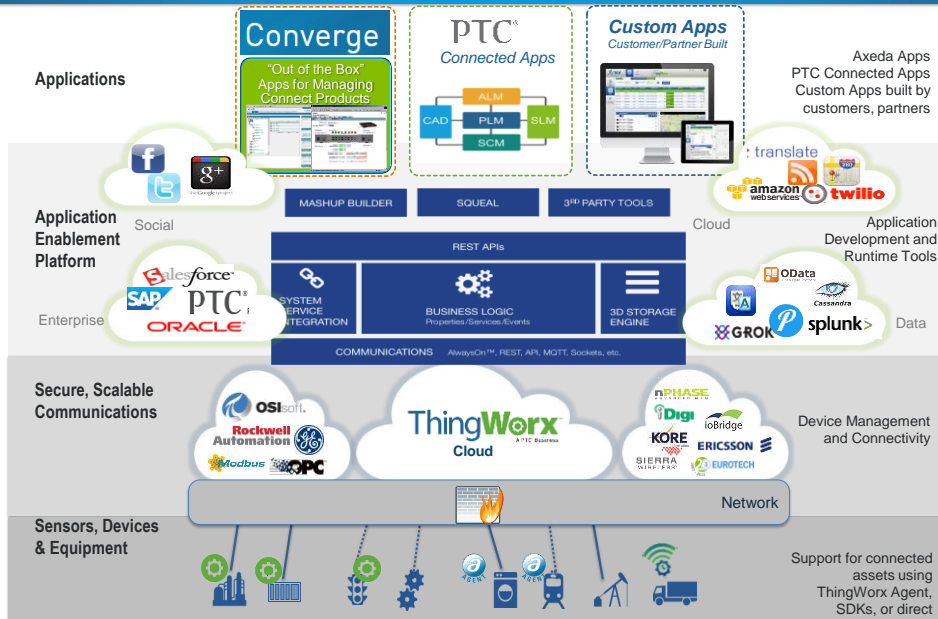"Standards are like toothbrushes, everyone agrees that they're a good idea but nobody wants to use anyone else's." *



* Attribution of who and when this was originally said this seems to have been lost to the ether

Age of the Universe | Things Get Bad For Us | Future of the Universe

PAST FUTURE

The Present Day

Some more fun facts about the future

Between 1 and 100 Trillion Years (1-100T): star formation ceases across the universe

Note: Arrows in the timeline represent incredibly large amounts of time passing.

110-120T: The last stars exhaust the remainder of their fuel.

$10^{76}$ Years: Matter now consists only of black holes

$10^{10^{120}}$ Years: The universe reaches its final energy state, or to put it pleasantly, "Heat Death." This means that energy levels in the universe are so low that nothing can happen anymore, anywhere. I don't get this either but it sounds upsetting.

Universal Standard that is applicable for all Connected Things is available

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Applications

Converge
"Out of the Box" Apps for Managing Connect Products

PTC®
Connected Apps

ALM
CAD | PLM | SLM
SCM

Custom Apps
Customer/Partner Built

Axeda Apps
PTC Connected Apps
Custom Apps built by customers, partners

Application Enablement Platform

Social

MASHUP BUILDER | SQUEAL | 3RD PARTY TOOLS

Cloud

Application Development and Runtime Tools

REST APIs

Enterprise

SYSTEM SERVICE INTEGRATION | BUSINESS LOGIC Properties/Services/Events | 3D STORAGE ENGINE

OData
Cassandra
GROK
splunk>

Data

COMMUNICATIONS AlwaysOn™, REST, API, MQTT, Sockets, etc.

Secure, Scalable Communications

OSIsoft.
Rockwell Automation GE
Modbus OPC

ThingWorx
Cloud
A PTC Business

nPHASE
Digi
KORE
SIERRA WIRELESS
ioBridge
ERICSSON
EUROTECH

Device Management and Connectivity

Network

Sensors, Devices & Equipment

Support for connected assets using ThingWorx Agent, SDKs, or direct

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- Discovery/invocation
    - Device discovery & registration
    - Metadata and capability discovery

- Bi-directional file transfer
    - Software updates, log/config file access, etc

- Streaming/tunneling
    - Remote access (SSH, VNC, etc.)
    - Images/video

- Device monitoring/management
    - Availability/connection status
    - Communications provisioning/monitoring

- Ignore the noise and the shiny objects, focus on you business and your industry.

- Keep abreast of the standardization efforts in your industry.

- Find a partner with a platform that doesn't force you into compromises with a generic "one size fits all" protocol.

- Choose a platform that can handle both your current and future connectivity needs – evolution and change are inevitable.
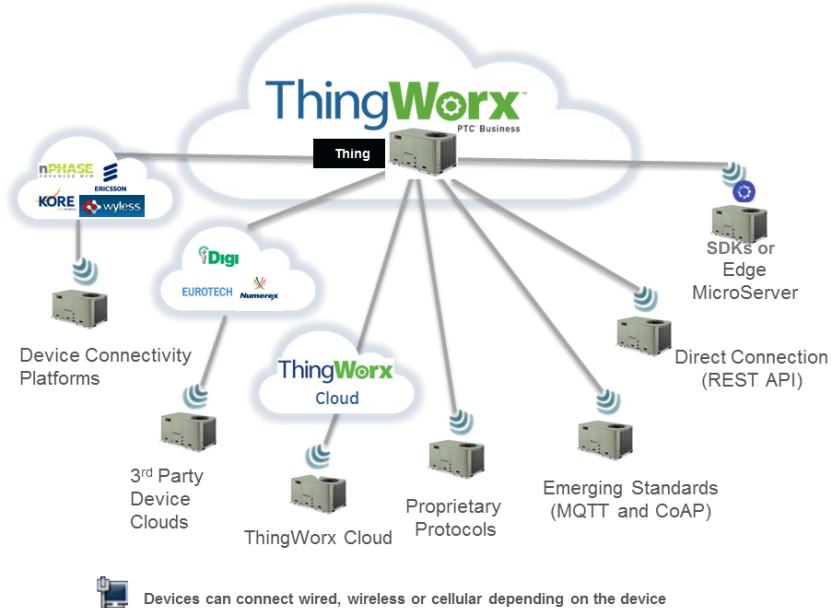
Devices can connect wired, wireless or cellular depending on the device
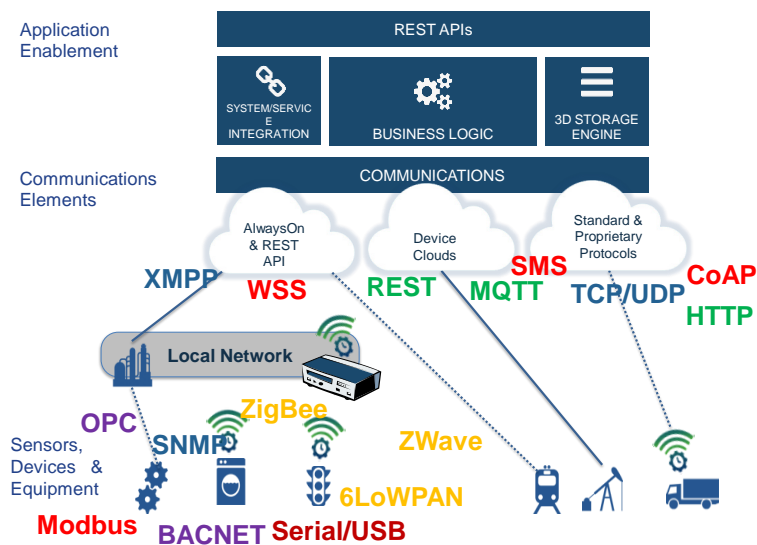
- Utilizes built-in ThingWorx platform extensibility model.

- Support for emerging standards such as CoAP and MQTT.

Sensor, Devices, Gateways, Equipment, Mobile Assets

- Can be used in situations where an existing deployment is already in place using either standard or proprietary protocols.

- Also used in new deployments where the edge device is highly resource constrained and the EMS or SDK is not appropriate.

**ThingWorx**

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Device Clouds    IoT Data Services
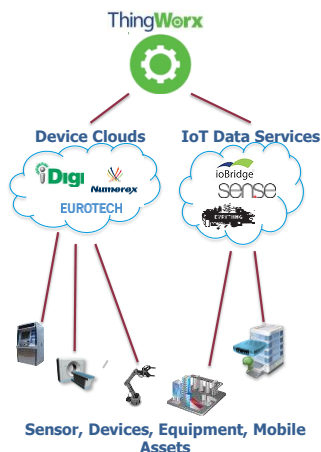
- Utilizes built-in ThingWorx platform extensibility model.

- Easy integration via HTTP REST, SOAP, and proprietary APIs.

- Used in situations where an existing deployment is already in place or service specific hardware is used.

Sensor, Devices, Equipment, Mobile Assets

- Existing integrations with iDigi, Eurotech, Xively, Sierra Wireless, Novatel and others.

**ThingWorx**
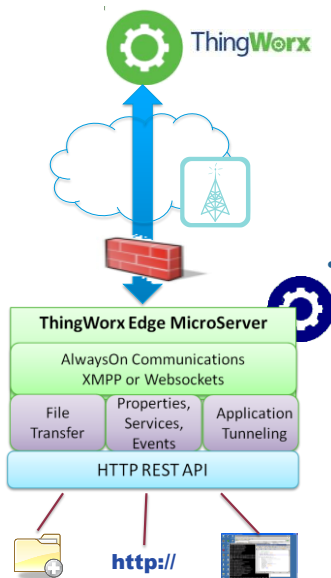
- AlwaysOn Provides Secure, Bi-Directional, Firewall Transparent, Low Latency interaction with devices.

- Also provides secure, audited file transfer and application tunneling (e.g. Remote Desktop, SSH).

- Transport agnostic – works in both wired and wireless settings.

- **EMS**
  - Lightweight (~750KB), pre-built, embeddable software component.
  - Used where edge intelligence and/or data aggregation is needed.
  - Exposes RESTful API to external components.
  - Supports Windows & Linux environments

- **SDKs**
  - Libraries for building custom agents
  - Full AlwaysOn capabilities
  - Multiple languages including Java, C, .NET, iOS, and Android
  - Language specific extensions for easy development

Device OnBoarding Examples

- Device Type: Fixed Function

- Connectivity Mechanism: SMS

- Integration:  Direct to SMS Gateway

- Approach: Modeled Smart Pill Dispenser

- in ThingWorx Composer. Parsed SMS messages to update properties and invoke services.

- Application: Alerted physician & caregiver  based on certain messages. Displayed status/warnings.

- Timeframe: Integration to SMS gateway: 0.5 days, message parsing: 0.5 days.

- **Total: On-Boarding: 1 day, Application: 2 days.**

- Device Type: General Purpose Gateway

- Connectivity Mechanism:   ThingWorx Protocol

- Integration:  ThingWorx Edge MicroServer

- Approach: EMS ran out of the box on OCG-D ARM/  Linux platform.  Used native EMS scripting to interact with  I/O and radio on OCG-D.

- Application: Device monitoring dashboard interacting with I/O on the OCG-D.

- Timeframe: EMS Integration to OCG-D: 1 hr, Lua scripting for I/O: 0.5 days, application development: 1 day.

- **Total: On-Boarding: 0.5 day, Application: 1 day.**

- Device Type: Fixed Function

- Connectivity Mechanism: Eurotech Everyware Device Cloud API

- Integration: ThingWorx Extension (pre-built)

- Approach: Use out-of-the-box integration to Eurotech cloud, w/Eurotech ReliaGATE for data acquisition. Modeled exercise equipment.

- Application: Personal fitness gamification, remote monitoring & proactive service of fitness equipment.

- Timeframe: Device Cloud integration: 0 days, modeling of equipment and specific device I/O: 2 days,

- **Total: On-Boarding: 2 days, Application: 5 days.**

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- Device Type: Sensor/Data Acquisition System

- Connectivity Mechanism: AlwaysOn

- Integration: ThingWorx C SDK

- Approach: C/C++ code using ARM environment. Complete, bi-directional connection.

- Application: Interactive dashboard displaying sensor readings, capturing history, and interaction with actuators.

- Timeframe: Custom "agent" development and model: 2 days

- **Total: On-Boarding: 2 days, Application: 1 day.**
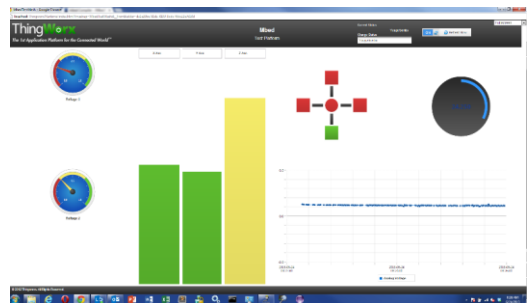
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## Integration Examples:
## AnyData OBD-II Device

- Device Type: Fixed Function

- Connectivity Mechanism:  Proprietary TCP/IP Protocol

- Integration:  Platform Extension

- Approach: Create Platform Extension in Java to handle AnyData OBD-II Device's proprietary TCP/IP protocol

- Application: World CNG – monitoring Taxi's, vehicle fleets that have been converted to Natural Gas

- Timeframe: Platform Protocol Extension:  4 days,  Modeling: 1 day, Mashups: 2 days.

- **Total: On-Boarding: 4 days, Application: 3 days.**

## Integration Examples:
## Manufacturing

- Device Type(s): Industrial controller (Siemens PLCs) and data historian (OSI PI).

- Connectivity Mechanism:  ThingWorx AlwaysOn through embedded OPC and ADO.NET to manufacturing equipment

- Integration:  ThingWorx EMS + .NET Adapter

- Approach: Use pre-built ThingWorx adapters to OPC and ADO.NET. Dynamically browse exposed sensors and map them to ThingWorx model components (Things).

- Application: Manufacturing monitoring/execution, bridge from cloud to production systems behind firewall

- Timeframe: 5 days

- **Total:  On-Boarding  1 day, Application 4 days**

- Device Type: Sensor/Data Acquisition System

- Connectivity Mechanism:  ThingWorx protocol and ZigBee

- Integration:  ThingWorx EMS

- Approach: EMS ran unmodified on Libelium Gateway. ThingWorx scripting used to connect to ZigBee protocol.  Libelium WaspMote and sensors types modeled as "Things".

- Application: Golf Course monitoring plus integration into work order system and chemical inventory/data.

- Timeframe: EMS Integration:  1 hour, Xbee Integration: 1 day, Modeling: 1 day, Application: 3 days.

- **Total: On-Boarding: 1 day, Application: 4 days.**

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https://MyServer/Thingworx/Things/BigBerthaTheMiner/Properties/CurrentTemp

Properties

Services

Events

Subscriptions

**CurrentTemp**

**OriginalPrice**

**Status**

**Location**

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https://MyServer/Thingworx/Things/BessieTheCow/Properties/CurrentTemp

Properties

Services

Events

Subscriptions

**CurrentTemp**

**OriginalPrice**

**Status**

**Location**

25
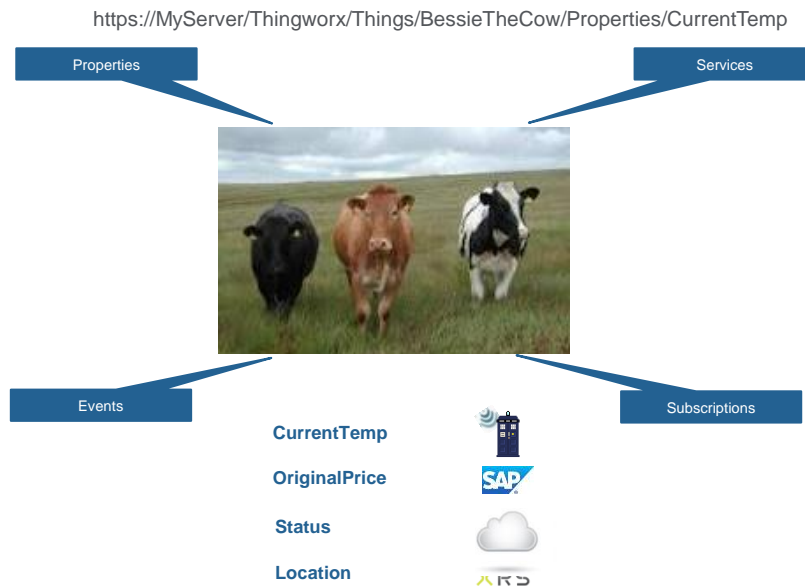
- Inclusion of devices, systems, and people as participants (and revenue sources)

- Extremely rapid on-boarding of new device types, regardless of connection (cellular, broadband, private network, etc.)

- A way to develop and deploy innovative applications 10X faster than the competition

# ThingWorx

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