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La estandarización como respuesta a las necesidades que plantea el desarrollo de la Internet de las cosas

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Organización



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- Infrastructure (ex: 6LowPAN, IPv4/IPv6, RPL)
- Identification (ex: EPC, uCode, IPv6, URIs)
- Comms / Transport (ex: Wifi, Bluetooth, LPWAN)
- Discovery (ex: Physical Web, mDNS, DNS-SD)
- Data Protocols (ex: MQTT, CoAP, AMQP, Websocket, Node)
- Semantic (ex: JSON-LD, Web Thing Model)
- Multi-layer Frameworks (ex: Alljoyn, IoTivity, Weave, Homekit)
- Security
- Industry Vertical (Connected Home, Industrial, etc)

Infrastructure



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- IPv6
- 6LoWPAN
- UDP (User Datagram Protocol)
- QUIC (Quick UDP Internet Connections, pronounced quick)
- Aeron - Efficient reliable UDP unicast, UDP multicast, and IPC message transport.
- uIP
- DTLS (Datagram Transport Layer)
- ROLL / RPL (IPv6 routing for low power/lossy networks)
- NanoIP
- Content-Centric Networking (CCN)
- Time Synchronized Mesh Protocol (TSMP)
-

Discovery



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- Bonjour/ZeroConf/Avahi/mDNS service discovery (multicast Domain Name System)
- UPnP (Universal Plug and Play)
- Physical Web
- HyperCat

Data Protocols



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- MQTT (Message Queuing Telemetry Transport)
 - MQTT-SN (MQTT For Sensor Networks)
 - Mosquitto: An Open Source MQTT v3.1 Broker
 - IBM MessageSight
- CoAP (Constrained Application Protocol)
 - SMCP
- XMPP (Extensible Messaging and Presence Protocol)
 - XMPP-IoT
- AMQP (Advanced Message Queuing Protocol)
- DDS (Data-Distribution Service for Real-Time Systems)
- JMS (Java Message Service)
- LLAP (lightweight local automation protocol)
- LWM2M (Lightweight M2M)
- SSI (Simple Sensor Interface)
- Reactive Streams
- REST (Representational state transfer) - RESTful HTTP
- HTTP/2SOAP (Simple Object Access Protocol), JSON/XML, ...
- Websocket
- JavaScript / Node.js

Communication / Transport layer



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- Ethernet
- WirelessHart
- DigiMesh
- ISA100.11a
- IEEE 802.15.4
- NFC
- ANT
- Bluetooth
- Eddystone
- ZigBee
- EnOcean
- WiFi
- WiMax
- LPWAN
 - Weightless
 - NB-IoT (Narrow-Band IoT)
 - LTE-MTC
 - EC-GSM-IoT (Extended Coverage-GSM-IoT)
 - LoRaWAN
 - RPMA (Random phase multiple access)
- GPRS/2G/3G/4G cellular

Semantic



- IOTDB
- SensorML
- Semantic Sensor Net Ontology - W3C
- Wolfram Language - Connected Devices
- RAML (RESTful API Modeling Language)
- SENML (Media Types for Sensor Markup Language)
- LsDL (Lemonbeat smart Device Language)

Multi-layer Frameworks



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- Alljoyn
- IoTivity
- IEEE P2413
- Thread
- IPSO Application Framework
- OMA LightweightM2M v1.0
- Weave
- Telehash - "JSON+UDP+DHT=Freedom"
- Cloud Frameworks
 - Watson IoT
 - Azure IoT Suite
 - AWS IoT
 - FIWARE
 - Kaa
 -

Security



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- Open Trust Protocol (OTrP) - A protocol to install, update, and delete applications and to manage security configuration in a Trusted Execution Environment (TEE).
- X.509 - Standard for public key infrastructure (PKI) to manage digital certificates and public-key encryption. A key part of the Transport Layer Security protocol used to secure web and email communication.

Vertical Specifics



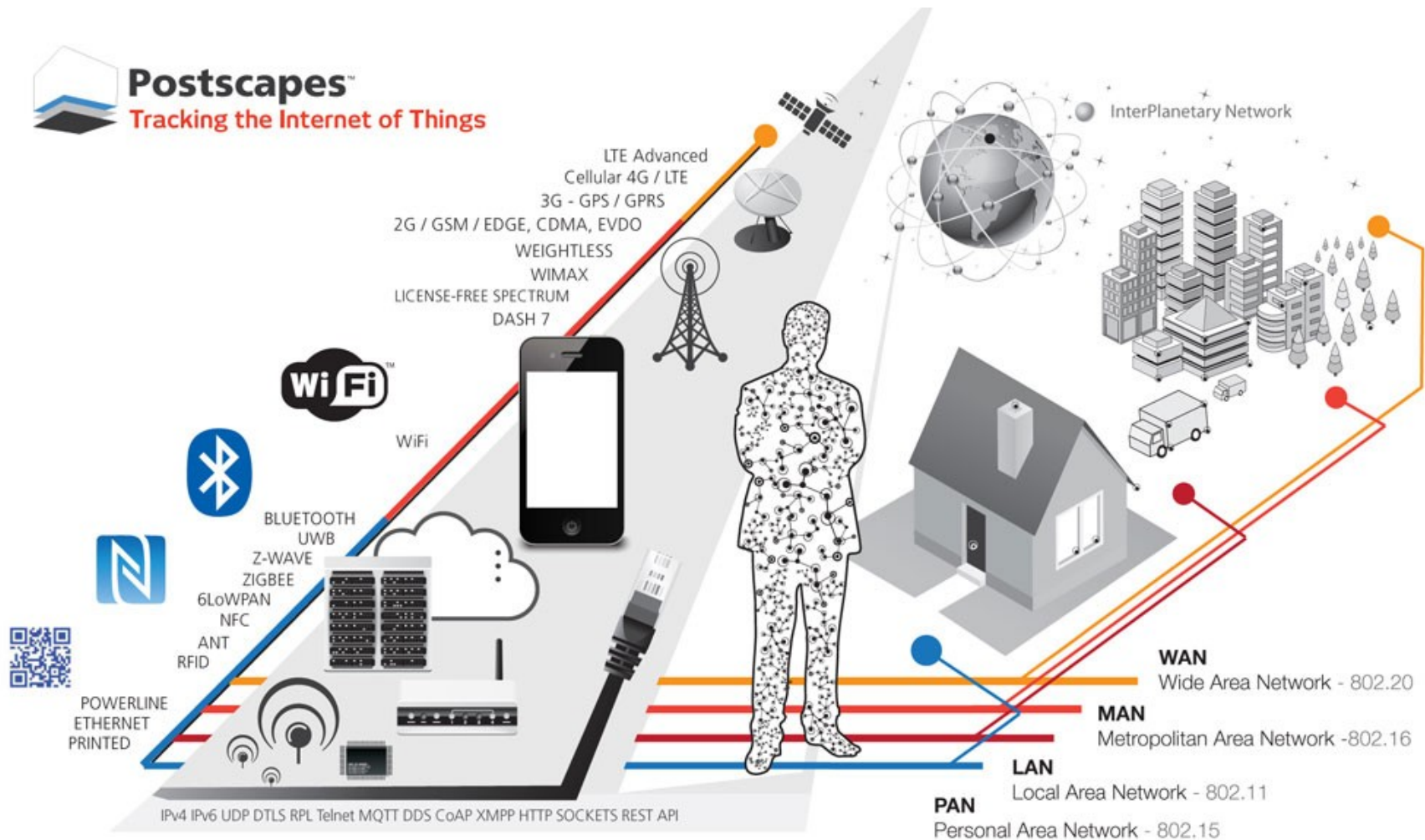
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- IEEE 1451: a family of Smart Transducer Interface Standards, describes a set of open, common, network-independent communication interfaces for connecting transducers (sensors or actuators) to microprocessors, instrumentation systems, and control/field networks.
- IEEE 1888.3-2013 - “IEEE Standard for Ubiquitous Green Community Control Network: Security”
- IEEE 1905.1-2013 - “IEEE Standard for a Convergent Digital Home Network for Heterogeneous Technologies”
- IEEE 802.16p-2012 - “IEEE Standard for Air Interface for Broadband Wireless Access Systems”
- IEEE 1377-2012 - “IEEE Standard for Utility Industry Metering Communication Protocol Application Layer”
- IEEE P1828 - “Standard for Systems With Virtual Components”
- IEEE P1856 - “Standard Framework for Prognostics and Health Management of Electronic Systems”

Communications: the big picture



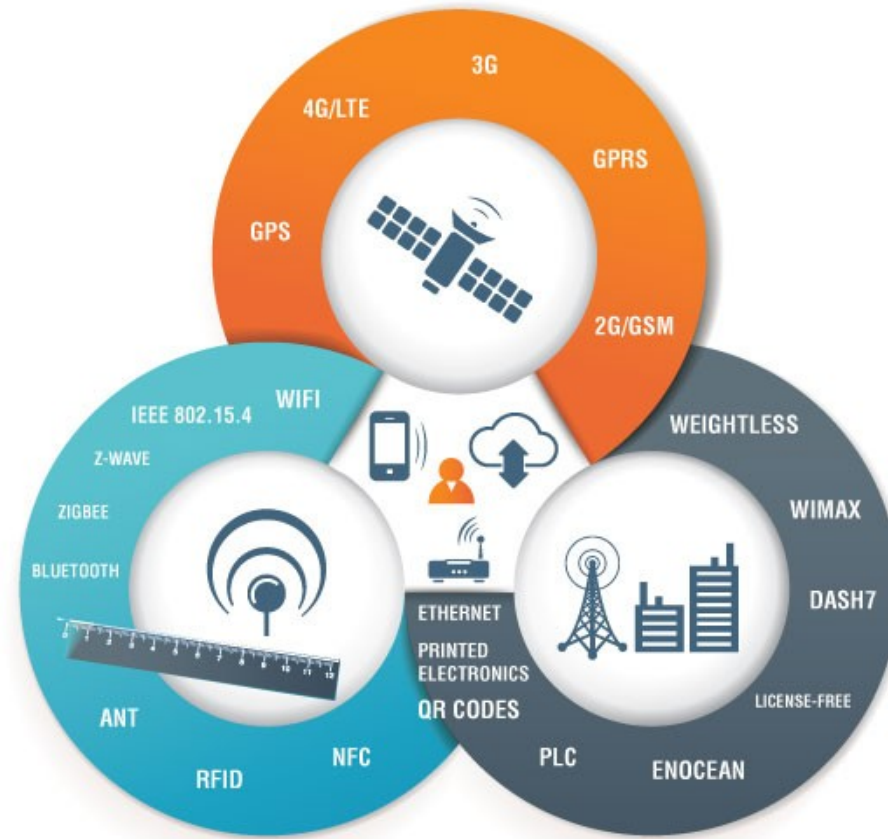
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Communications: the big picture



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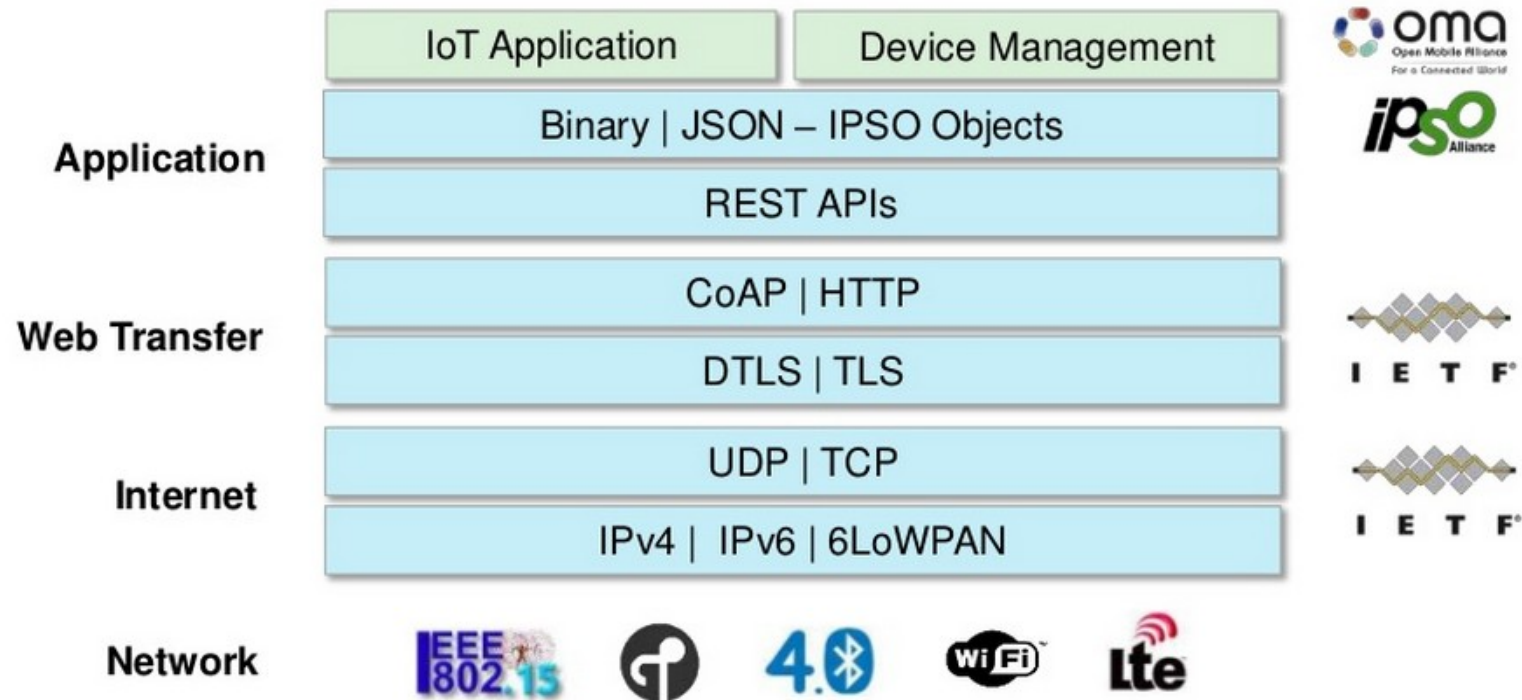


The complete stack



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Remember the I in IoT!



ARM

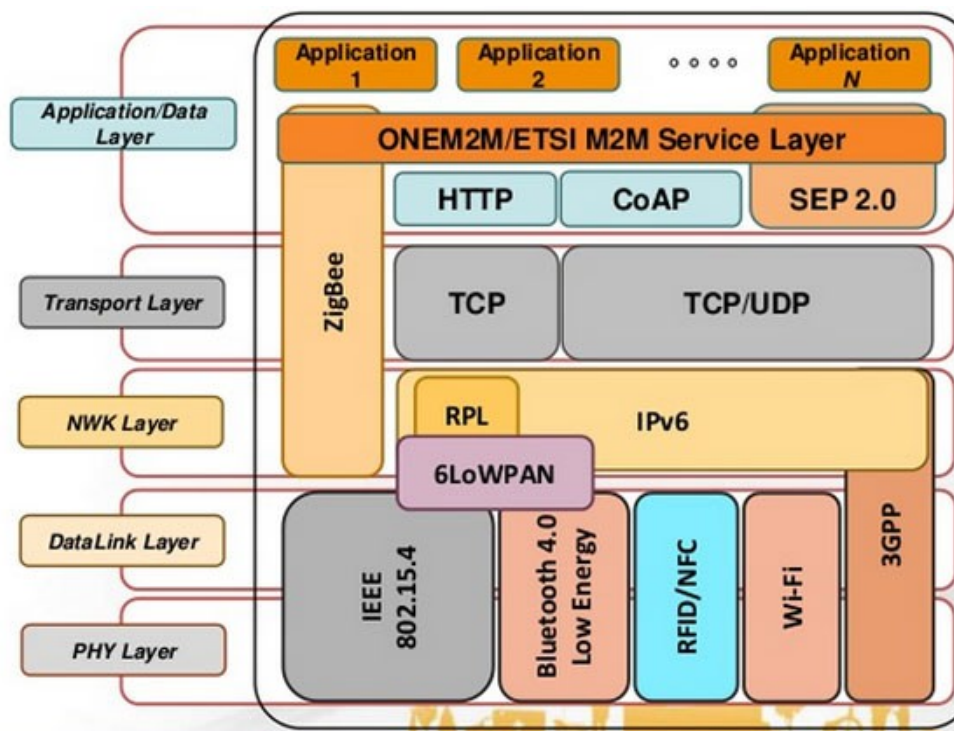
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Ref: Simon Ford - Director of IoT Platforms ARM

The complete stack



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Ref: EU Butler Project - Communication Issues

Organizations



- ETSI (European Telecommunications Standards Institute)
 - Connecting Things Cluster
- IETF (Internet Engineering Task Force)
 - CoRE working group (Constrained RESTful Environments)
 - 6lowpan working group (IPv6 over Low power WPAN)
 - ROLL working group (Routing Over Low power and Lossy networks)
- IEEE (Institute of Electrical and Electronics Engineers)
 - IoT "Innovation Space"
- OMG (Object Management Group)
 - Data Distribution Service Portal
- OASIS (Organization for the Advancement of Structured Information Standards)
 - MQTT Technical Committee
- OGC (Open Geospatial Consortium)
 - Sensor Web for IoT Standards Working Group
- IoT-A
 - "The European Lighthouse Integrated Project addressing the Internet-of-Things Architecture, proposes the creation of an architectural reference model together with the definition of an initial set of key building blocks."

Organizations



- OneM2M
 - "The purpose and goal of oneM2M is to develop technical specifications which address the need for a common M2M Service Layer that can be readily embedded within various hardware and software, and relied upon to connect the myriad of devices in the field with M2M application servers worldwide."
- OSIOT
 - "An organization with the single focus to develop and promote royalty-free, open source standards for the emerging Internet of Things."
- IoT-GSI (Global Standards Initiative on Internet of Things)
- ISA International Society of Automation
- W3C
 - Semantic Sensor Net Ontology
 - Web of Things Community Group
- EPC Global
 - The IEC (International Electrotechnical Commission), and ISO (International Organization for Standardization), through the JTC (Joint Technical Committee)
- IRTF RRG (Routing research group)
- IRTF HIPRG (Host identity protocol research group)
- Eclipse Paho Project
 - "The scope of the Paho project is to provide open source implementations of open and standard messaging protocols that support current and emerging requirements of M2M integration with Web and Enterprise middleware and applications. It will include client implementations for use on embedded platforms along with corresponding server support as determined by the community."
- OpenWSN
 - "Serves as a repository for open-source implementations of protocol stacks based on Internet of Things standards, using a variety of hardware and software platforms."

Conclusiones?



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- Arquitectura compleja, cientos de protocolos en diferentes capas
- Decenas de opciones por capa
- Decenas de organismos de estandarización
- IoT es “software developer driven”..
 - Abstracciones!
 - No necesariamente eficiente
- ¿Cómo reducir la complejidad?
 - ¿es necesario?

Referencias



- Postcapes IoT. En línea:
<http://www.postscapes.com/internet-of-things-protocols/>
- Challenges in IoT Networking via TCP/IP Architecture by Wentao Shang, Yingdi Yu, Ralph Droms, Lixia Zhang. NDN, Technical Report NDN-0038. En línea:
<https://named-data.net/publications/techreports/ndn-0038-1-challenges-iot/>