# The Top 10 Challenges for the Internet of Things (IoT)

By: Craig K. Harmon, Q.E.D. Systems

2014-05-30

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# Top 10 Challenges for IoT

10. Defining IoT
9. Is the application provincial or global?
8. Cooperation
7. Sensor interfaces
6. Standardization
5. Data content
4. Defining location & time
3. Unique identification
2. Transport protocol & security
1. Telecommunications


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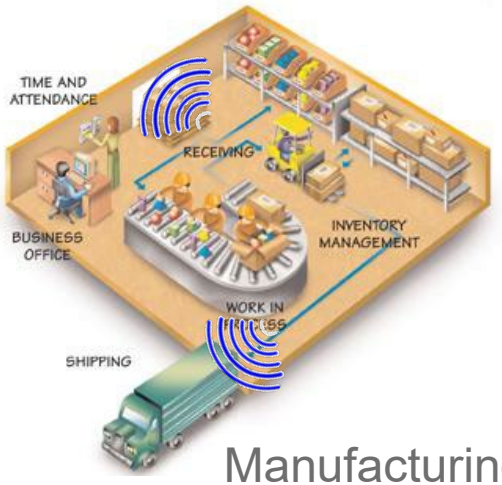
# #10 . . . Defining IoT

- The definition depends upon who you ask
  - RFID-centric
  - Sensor-centric
  - Location-centric

*Global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on, existing and evolving, interoperable information and communication technologies*


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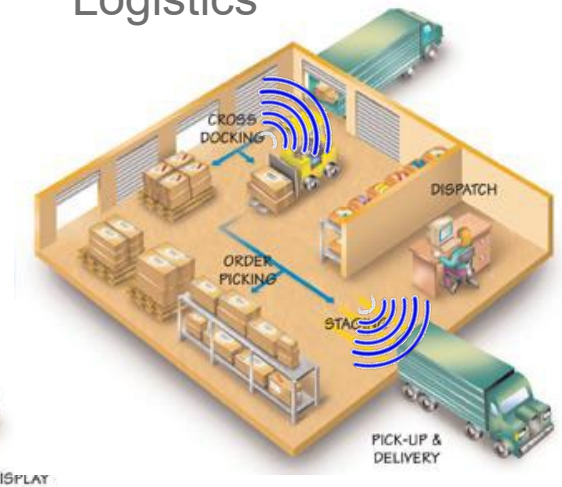
# With RFID




Manufacturing

???

Distribution / Logistics




???

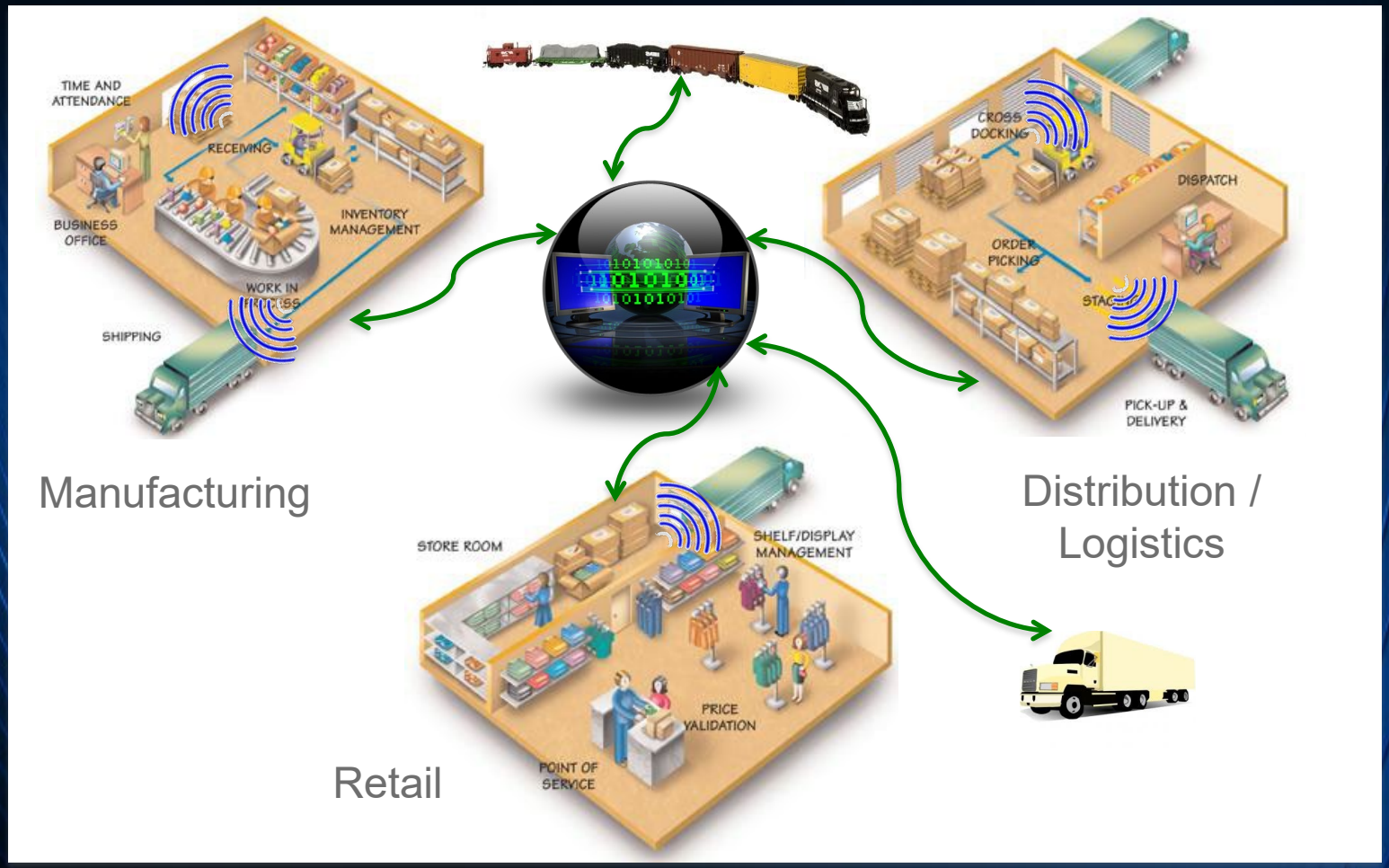



Retail

???


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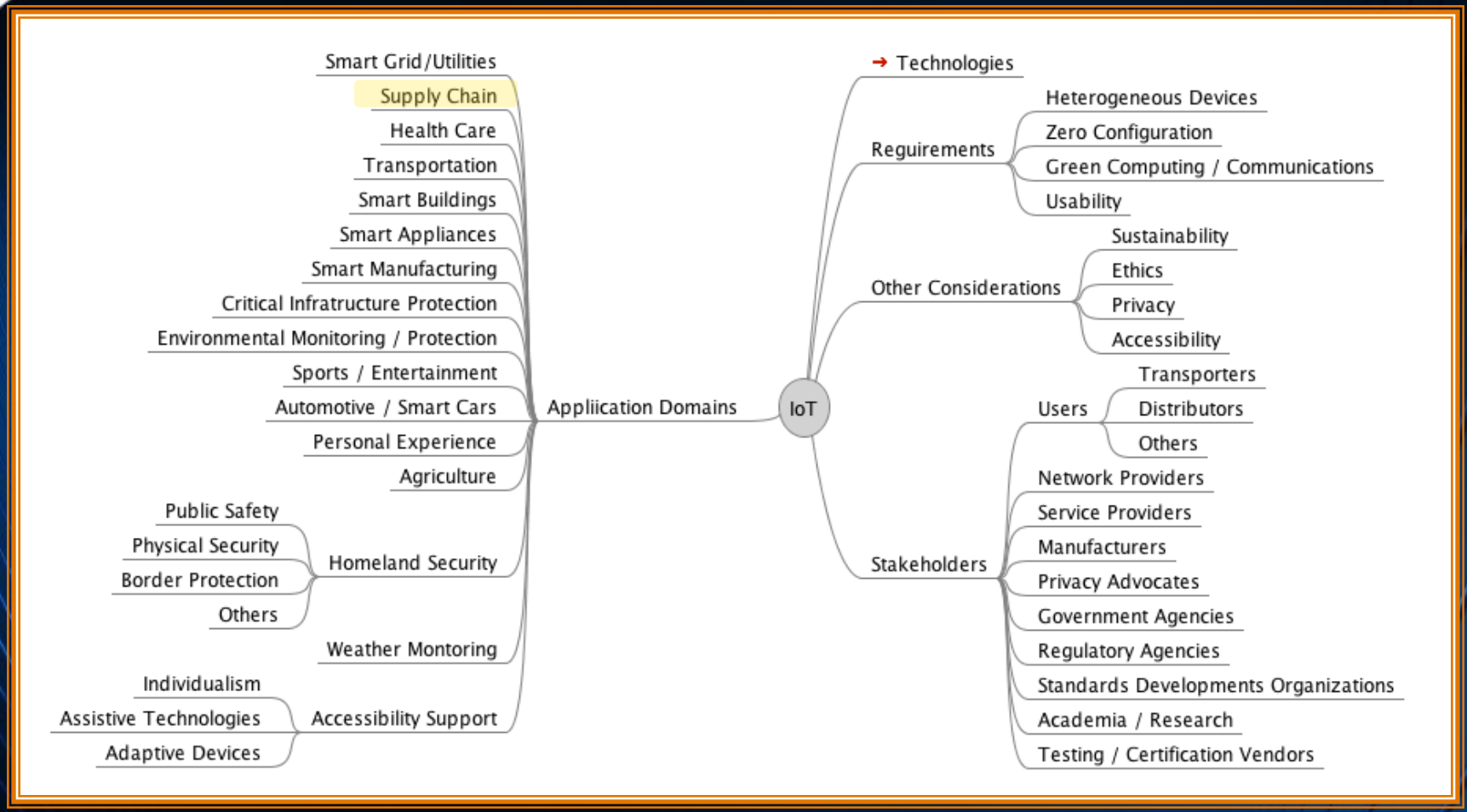
# With IoT





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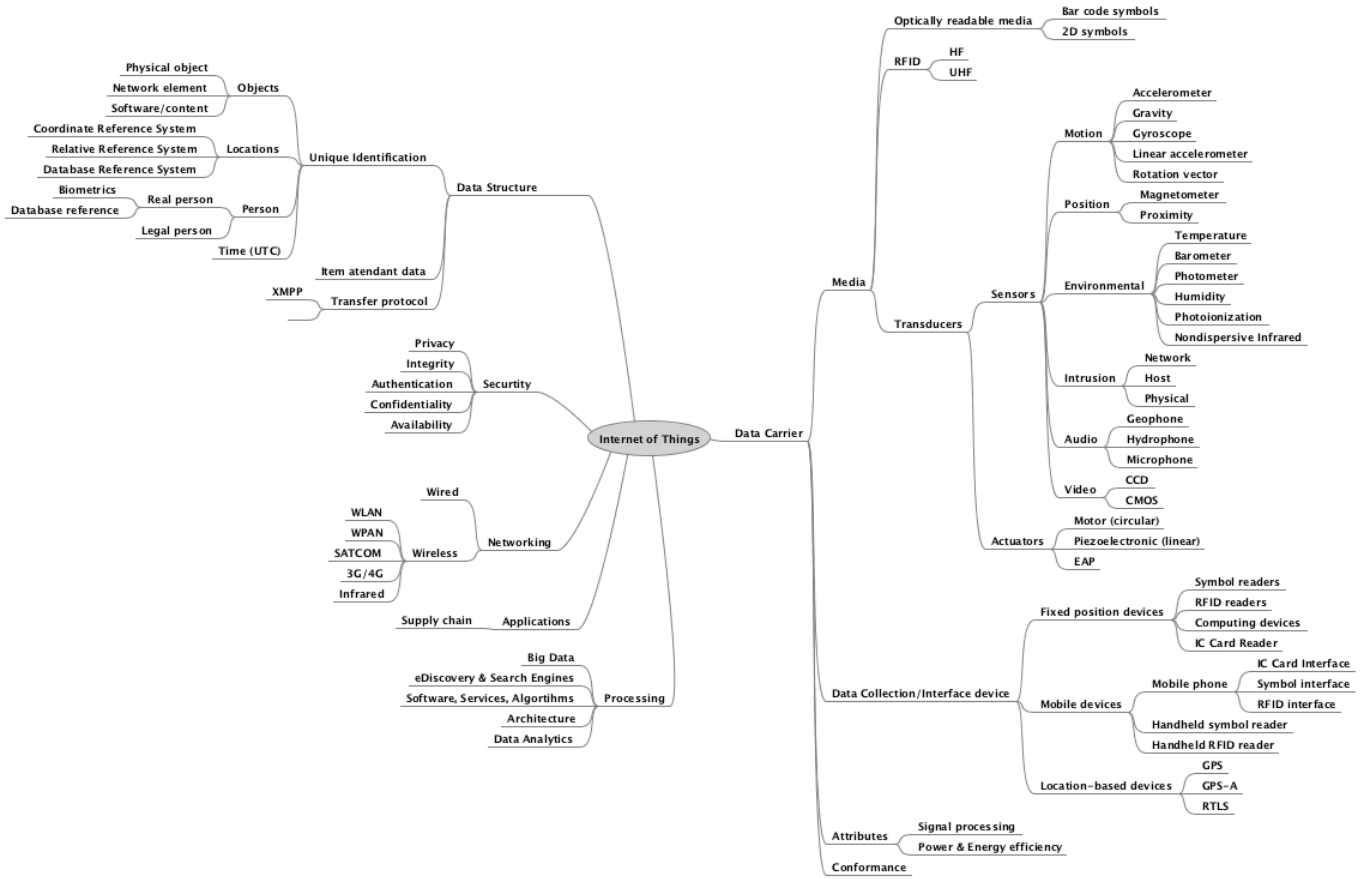
# The Internet of Things (Basics)





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# The Internet of Things (Technologies)





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# QR Code & IoT – How it works





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# QR Code & IoT – How it works




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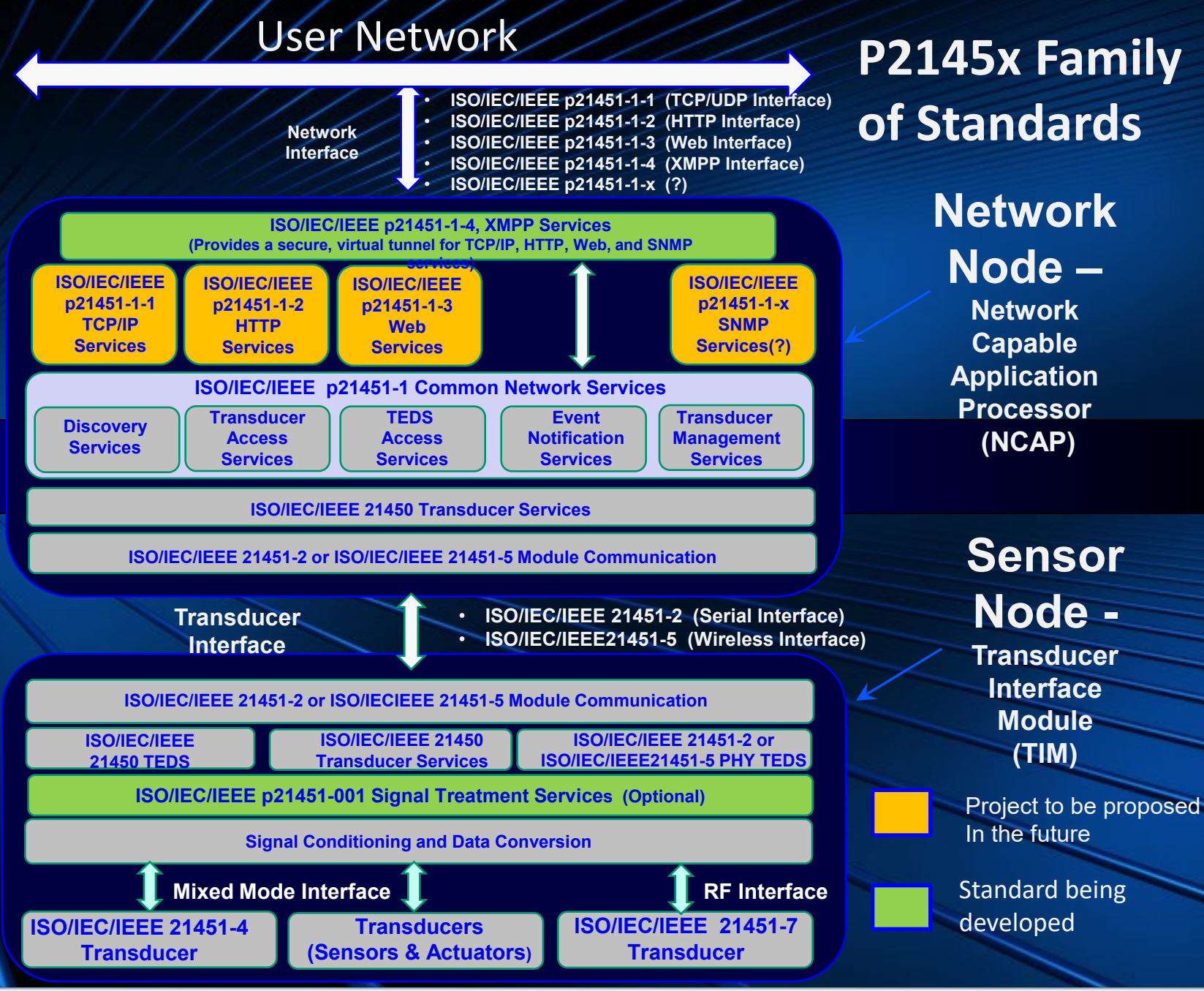
# #9 . . . Is the Application Provincial or Global?

- Home automation
- Smart grid
- Smart agriculture
- Smart manufacturing
- Assistive technologies
- Smart healthcare
- Smart transportation
- Environmental monitoring
- **Global supply chain / Physical internet**


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# #7
# Sensor Interfaces


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# P2145x Family of Standards

## Network Node – Network Capable Application Processor (NCAP)

## Sensor Node - Transducer Interface Module (TIM)

Project to be proposed In the future

Standard being developed

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# #5
# Data Content


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# #5 . . . Data Content

- Putting all of the disparate output from different devices into a manageable form
- Each device type follows its own unique data content standards


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# Use Case – ISO 18576 – RTIs

**ISO 18576, *Internet of Things (IoT) in the supply chain — Returnable transport items (RTIs)***
Sensor threshold exceeded connected to mobile device on 4G network: Identify sensor, identify exceeded threshold, identify item (UII) to which mobile device is attached, identify mobile device (IMEI), identify the SIM IC (ICCID), identify subscriber (IMSI), identify read location, identify time of read, identify MAC address of connection to Internet, identify destination resource address

| Field | Header Name | Header Decimal | Header Hexadecimal | URN | Data |
|---|---|---|---|---|---|
| Identify destination resource address | IPv6 | 97 | 0x61 | urn:oid:1.0.29161.97 | 2001:0db8:85a3:0042:1000:8a2e:0370:7334 |
| Identify sensor | EUI-64 | 82 | 0x52 | urn:oid:1.0.29161.82 | ACDE48FFFE232567 |
| Sensor value | --- | --- | --- | --- | From 21451-7 (or other) |
| Identify NCAP address of connection to Internet | EUI-64 (MAC) | 83 | 0x53 | urn:oid:1.0.29161.83 | 00127FFFFEEB6B40 |
| Identify port on NCAP/Gateway | --- | --- | --- | 1.0.29161.83.2 | 2 (urn:oid:1.0.29161.83.2) |
| Identify item | UII (25B) | 80 | 0x50 | urn:oid:1.0.29161.80 | UN433257110123456789 |
| Identify mobile device | IMEI | 177 | 0xB1 | urn:oid:1.0.29161.177 | 351451208401216 |
| Identify read location | GPS ID (WGS 84) | 158 | 0x9E | urn:oid:1.0.29161.158 | 41.99869/-91.608037/237 |
| Identify time of read | UTC | 159 | 0x9F | urn:oid:1.0.29161.159 | 2013-03-22T19:33:51Z |


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# #3
# Unique Identification


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# #3 . . . Unique Identification

*I have six honest serving men*

*They taught me all I knew*

*Their names are What, and Where and When;*

*and Why and How and Who.*

*- Rudyard Kipling (1865-1936)*

**With apologies to the celebrated English poet and author, the supply chain submits that a seventh honest man is missing whose name is "Which".**

**And, as in Macbeth, there are three "Whiches":**

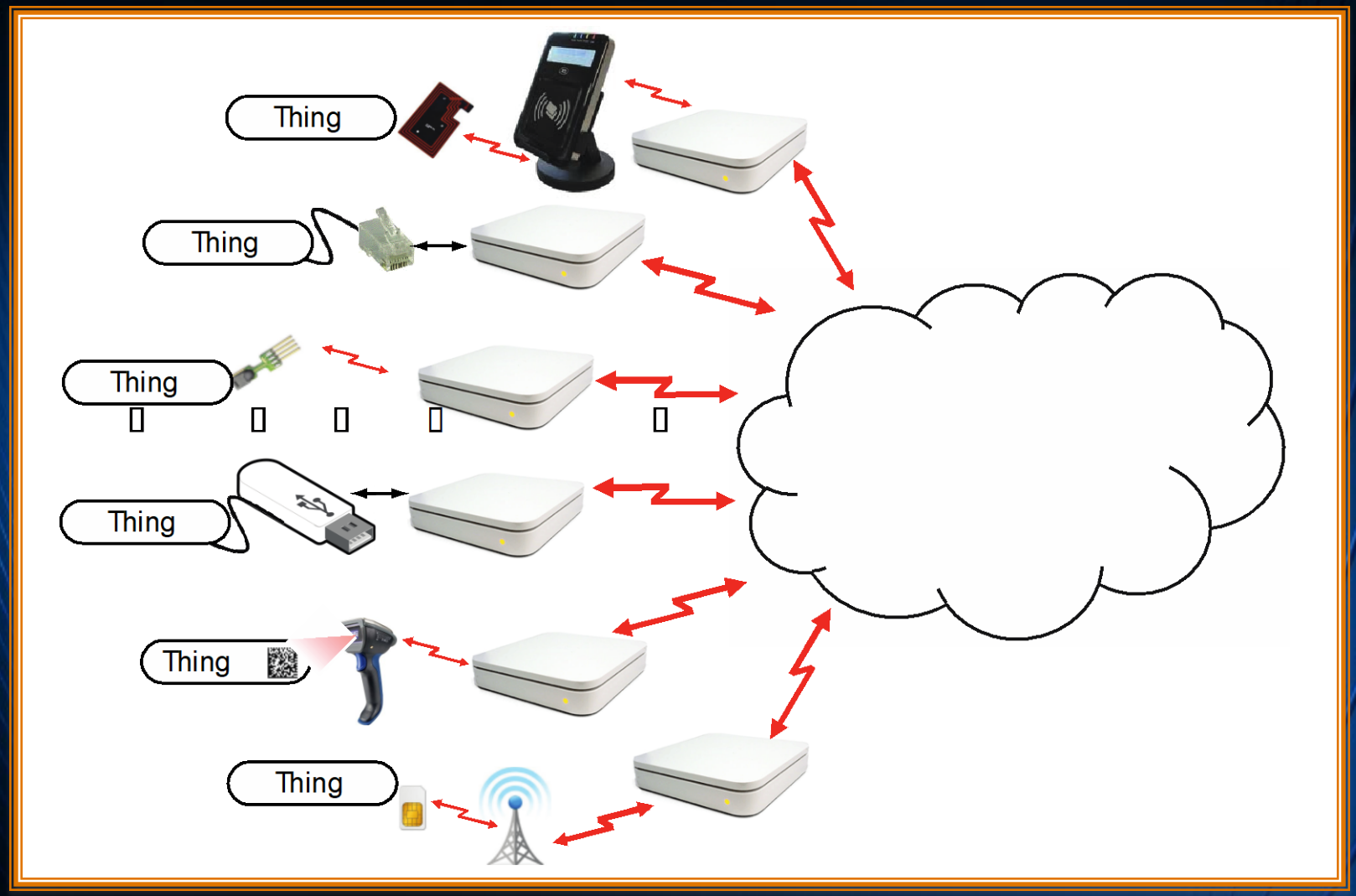
- **"Which one",**
- **"Which group",**
- **"Which transport unit".**

**For these seven "questions" underpin the very heart of the supply chain, traceability, tracking, and chain of custody.**

| | | |
|---|---|---|
| WHO | Individual | Identification of the individual |
| WHAT | Product code | Identification of the product (SKU) |
| WHICH (Item) | Unique item | Globally unique item serial number |
| WHICH (Group) | Specific group | Identification of the lot or batch |
| WHICH (Container) | Package ID | Globally unique transport unit identifier |
| WHERE | Location (Storage/Postal/ Lat Long Alt) | Unambiguous identification of the location |
| WHEN | At what time | Unambiguous time stamp |
| HOW | Method | Unambiguous identification of the process |
| WHY | Authority | Purchase Order/ Work Order |


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# To Which "Thing" are We Referring





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# Unique ID Header Values

| Header (binary) | Header (0xnn) | Header (decimal) | Significance | OID |
|---|---|---|---|---|
| 0000 0000 | 0 | 0 | Unprogrammed media | urn:oid:1.0.29161.0 |
| 0100 0001 | 41 | 65 | ISO UII Product (n) | urn:oid:1.0.29161.65 |
| 0100 0010 | 42 | 66 | ISO UII Transport Unit (n) | urn:oid:1.0.29161.66 |
| 0100 0011 | 43 | 67 | ISO UII RTI (n) | urn:oid:1.0.29161.67 |
| 0100 0100 | 44 | 68 | ISO UII Containerized Cargo () | urn:oid:1.0.29161.68 |
| 0100 0101 | 45 | 69 | ISO UII Product (an) | urn:oid:1.0.29161.69 |
| 0100 0110 | 46 | 70 | ISO UII Transport Unit (an) | urn:oid:1.0.29161.70 |
| 0100 0111 | 47 | 71 | ISO UII RTI (an) | urn:oid:1.0.29161.71 |
| 0100 1000 | 48 | 72 | ISO UII Containerized Cargo (an) | urn:oid:1.0.29161.72 |
| 0100 1001 | 49 | 73 | ISO UII Product & Product Package (25S) | urn:oid:1.0.29161.73 |
| 0100 1010 | 4A | 74 | ISO UII Product & Product Package (37S) | urn:oid:1.0.29161.74 |
| 0100 1011 | 4B | 75 | ISO UII Transport Unit (J) | urn:oid:1.0.29161.75 |
| 0100 1100 | 4C | 76 | ISO UII Transport Unit (1J) | urn:oid:1.0.29161.76 |
| 0100 1101 | 4D | 77 | ISO UII Transport Unit (2J) | urn:oid:1.0.29161.77 |
| 0100 1110 | 4E | 78 | ISO UII Transport Unit (5J) | urn:oid:1.0.29161.78 |
| 0100 1111 | 4F | 79 | ISO UII Transport Unit (6J) | urn:oid:1.0.29161.79 |
| 0101 0000 | 50 | 80 | ISO UII Returnable Transport Item (25B) | urn:oid:1.0.29161.80 |
| 0101 0001 | 51 | 81 | UII Containerized Cargo (7B) | urn:oid:1.0.29161.81 |
| 0101 0010 | 52 | 82 | EUI-64 Sensor ID | urn:oid:1.0.29161.82 |
| 0101 0011 | 53 | 83 | EUI-64 MAC Address | urn:oid:1.0.29161.83 |
| 0101 0100 | 54 | 84 | EUI-64 802.15.4 ID | urn:oid:1.0.29161.84 |


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# Unique ID Header Values

| Header (binary) | Header (0xnn) | Header (decimal) | Significance | OID |
|---|---|---|---|---|
| 0101 1001 | 59 | 89 | NII – 7812-1 | urn:oid:1.0.29161.89 |
| 0101 1010 | 5A | 90 | NII - 15459 | urn:oid:1.0.29161.90 |
| 0101 1011 | 5B | 91 | NII - 3166 | urn:oid:1.0.29161.91 |
| 0101 1100 | 5C | 92 | MII Construct 1 (ISO/IEC 29174-1) | urn:oid:1.0.29161.92 |
| 0101 1101 | 5D | 93 | MII Construct 2 (ISO/IEC 29174-1) | urn:oid:1.0.29161.93 |
| 0101 1110 | 5E | 94 | MII Construct 3 (ISO/IEC 29174-1) | urn:oid:1.0.29161.94 |
| 0101 1111 | 5F | 95 | MII Construct 4 (ISO/IEC 29174-1) | urn:oid:1.0.29161.95 |
| 0110 0001 | 61 | 97 | IPv6 | urn:oid:1.0.29161.97 |
| 0111 0001 | 71 | 113 | E.164 (MSISDN) | urn:oid:1.0.29161.113 |
| 1000 0001 | 81 | 129 | IMSI (E.212) | urn:oid:1.0.29161.129 |
| 1000 0010 | 82 | 130 | ICCID | urn:oid:1.0.29161.130 |
| 1000 1111 | 8F | 143 | Jabber ID | urn:oid:1.0.29161.143 |
| 1001 1101 | 9D | 157 | TagID | urn:oid:1.0.29161.157 |
| 1001 1110 | 9E | 158 | GPS ID (WGS 84) | urn:oid:1.0.29161.158 |
| 1001 1111 | 9F | 159 | UTC | urn:oid:1.0.29161.159 |
| 1011 0001 | B1 | 177 | IMEI | urn:oid:1.0.29161.177 |
| 1101 0001 | D1 | 209 | IPv4 | urn:oid:1.0.29161.209 |
| 1111 0001 | F1 | 241 | ITU-T H.642/uCode UII | urn:oid:1.0.29161.241 |
| 1111 1111 | FF | 255 | Reserved for Extensibility | urn:oid:1.0.29161.255 |


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# #2
# Transport Protocol & Security


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# #2 . . . Transport Protocol & Security

- Regardless of the transport protocol, security must be of primary importance
- And while there are some refinements that need to be made to their XEPs, XMPP remains one of the best choices for a transport protocol


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# #1

# Telecommunications


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# #1 . . . Telecommunications

- Near Field Communications (NFC)
- Wireless Personal Area Networks (WPAN)
  - ISO/IEC/IEEE 802.15
    - ZigBee
    - Bluetooth
- Local Area Networks (LAN)
  - WiFi
  - ISO/IEC/IEEE 802.11
  - RFID networks
- Wireless Wide Area Networks (WWAN)
  - 2G, 3G, 4G, LTE, 5G


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# 5G

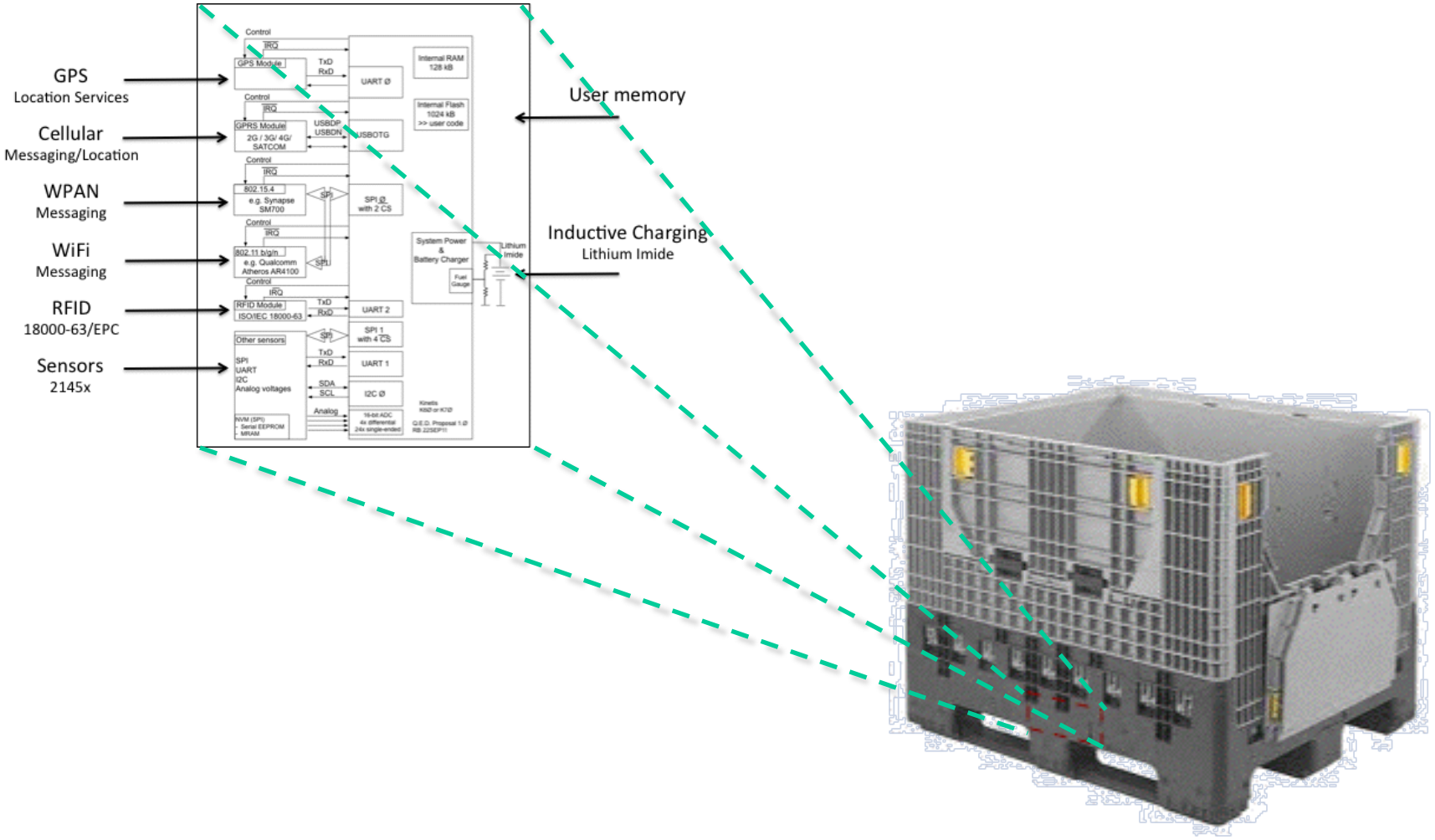
- The 5G-Infrastructure-PPP is a 1.4 Billion Euro joint initiative between the European ICT industry and the European Commission to rethink the infrastructure and to create the Next generation of communication networks and services that will provide ubiquitous super-fast connectivity and seamless service delivery in all circumstances


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# Supply Chain Applications of IOT


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# etPallet Electronics

**GPS**
Location Services

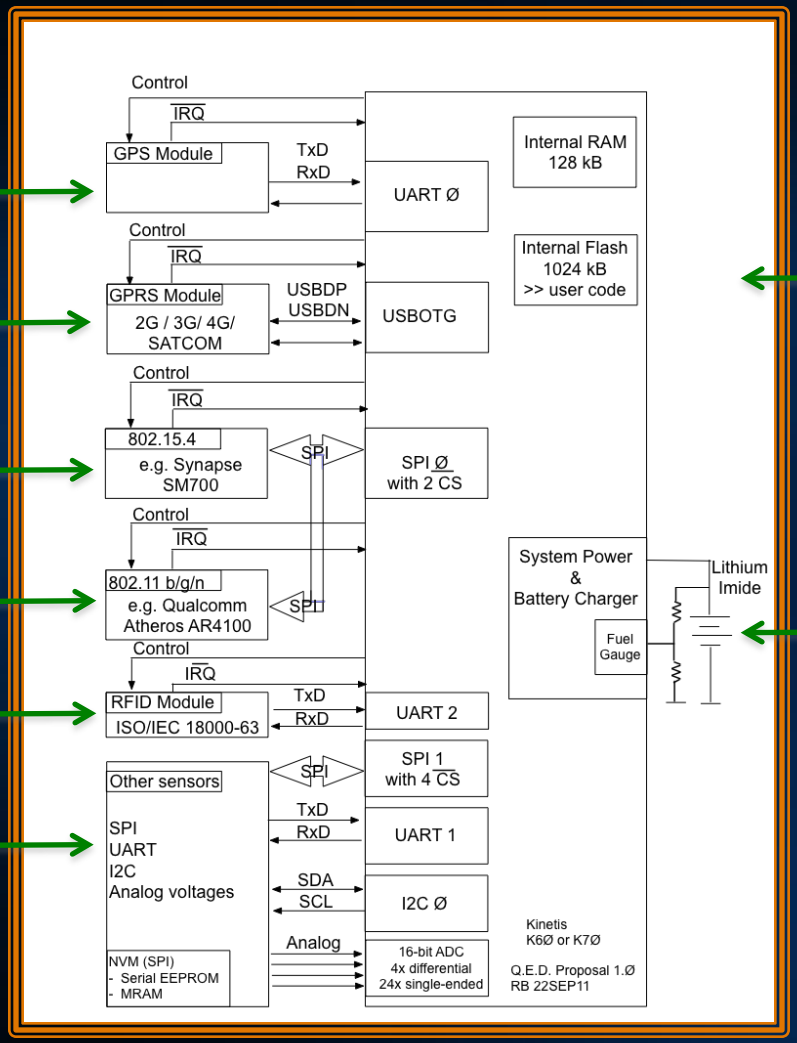
**Cellular**
Messaging/Location

**WPAN**
Messaging

**WiFi**
Messaging

**RFID**
18000-63/EPC

**Sensors**
2145x

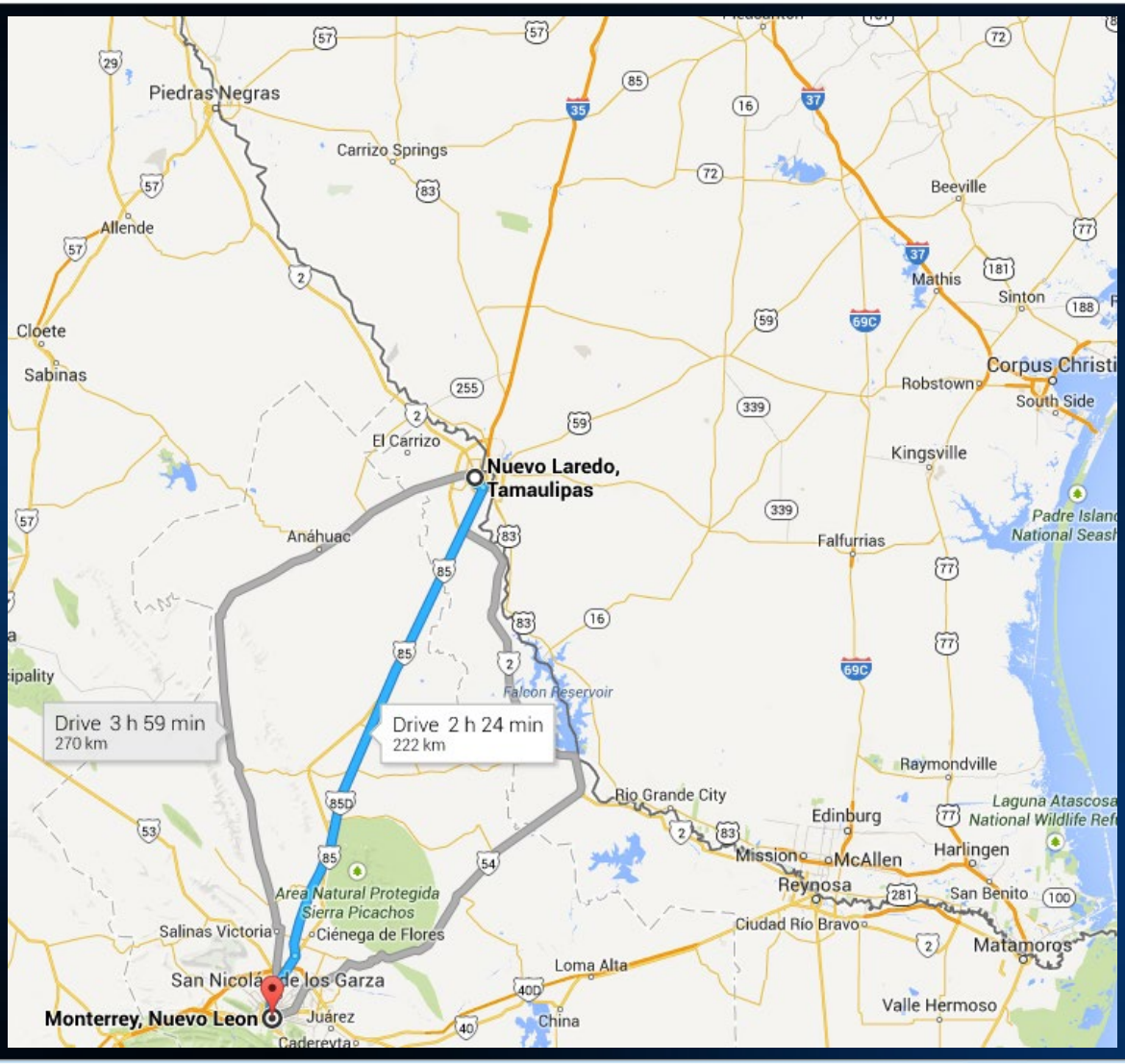



**User memory**

**Inductive Charging**
Lithium Imide

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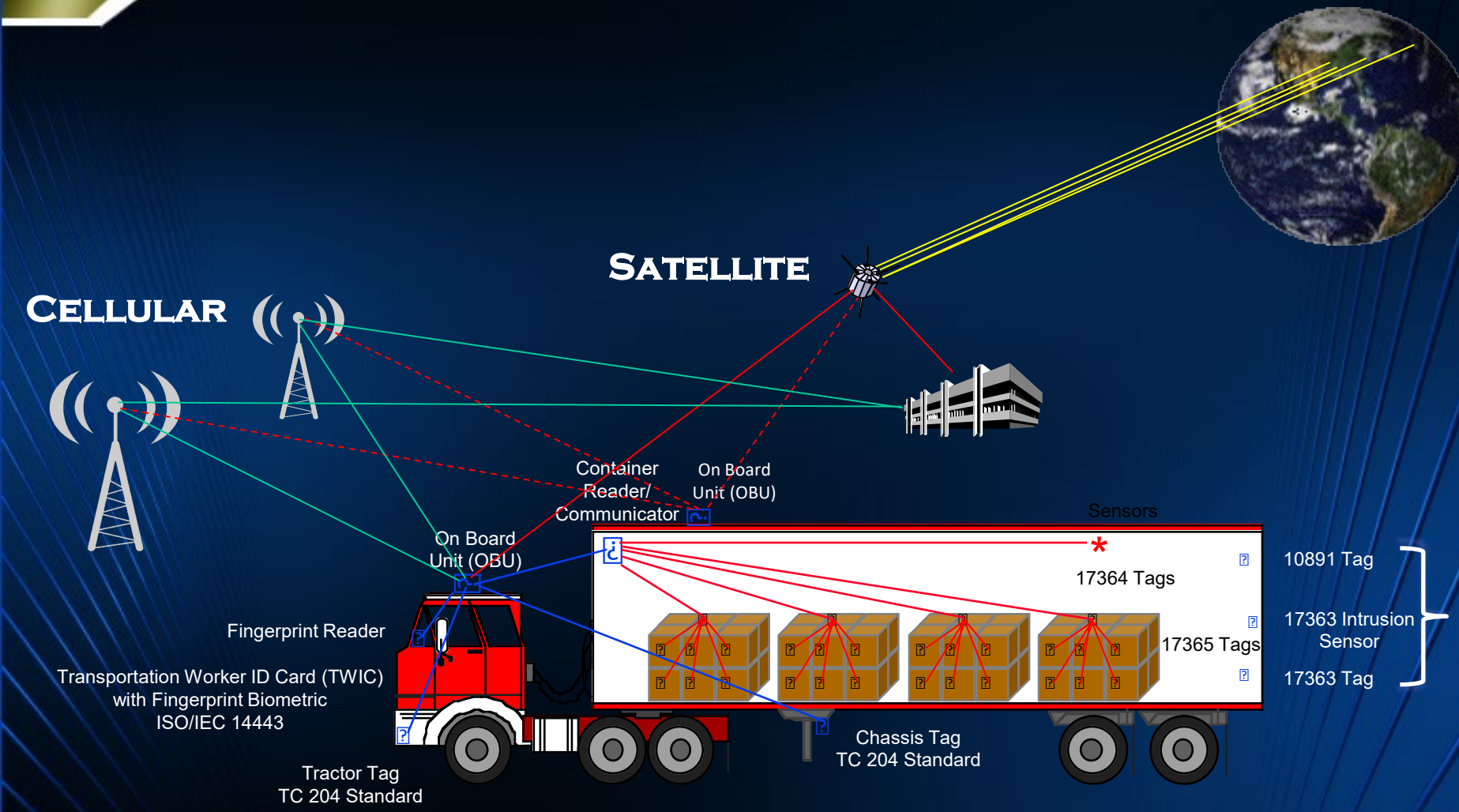
# Protecting the Supply Chain with IOT (Electronic Fencing)



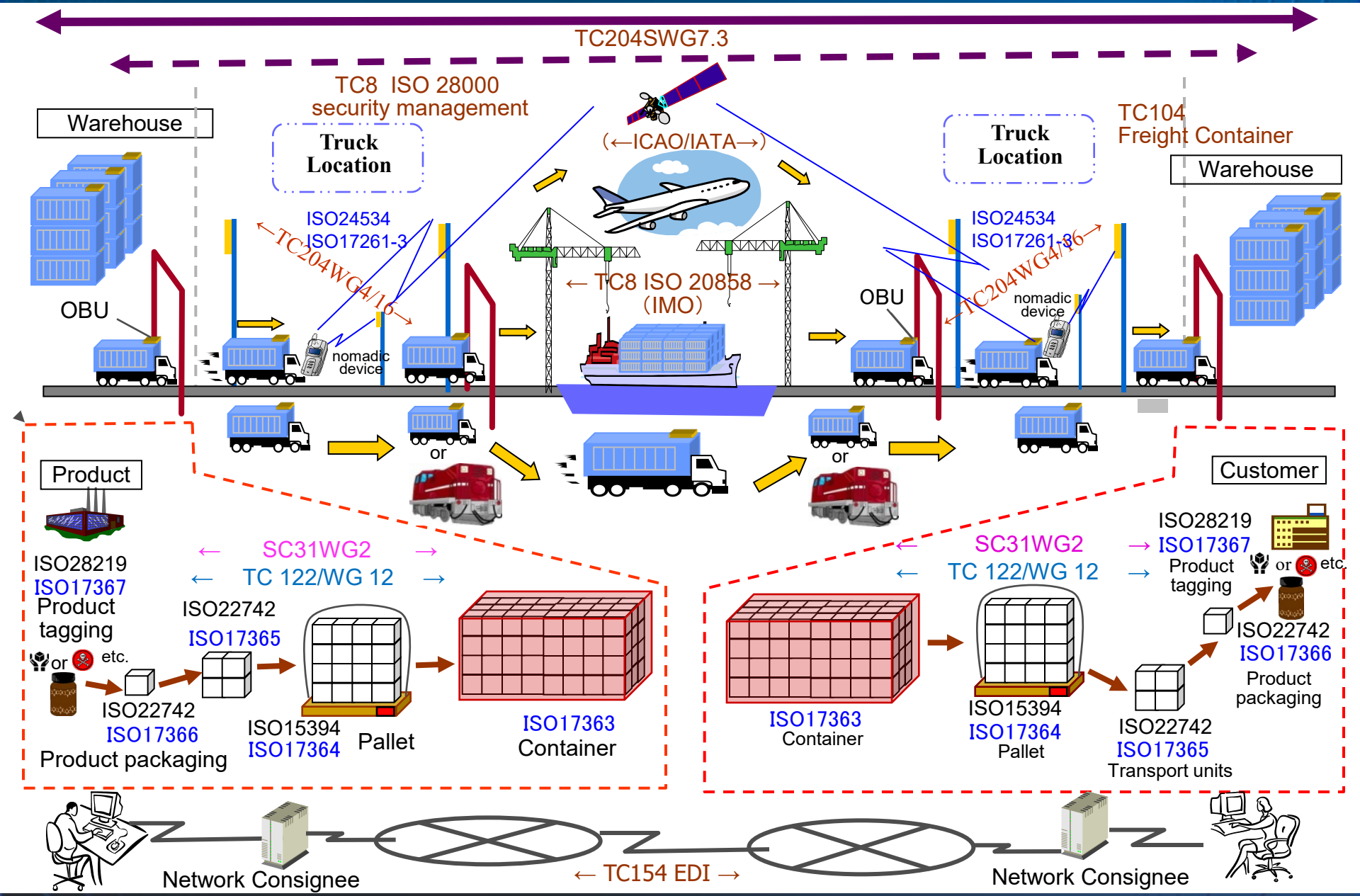


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# Supply Chain Monitoring




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# Top 10 Challenges for IoT

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9. Is the application provincial or global?
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7. Sensor interfaces
6. Standardization
5. Data content
4. Defining location & time
3. Unique identification
2. Transport protocol & security
1. Telecommunications


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# Craig K. Harmon • President & CEO
# Q.E.D. Systems

- Chair, ASC MH 10 and U.S. TAG to ISO TC 122 (Packaging)
- Chair, ISO TC 122/WG 12 – *Supply chain applications of logistics technology*
- TC 122 Liaison Officer to JTC 1/SC 31, TC 104, TC 204, TC 145, JTC 1/SC 6, ITU JCA-IoT, JTC 1/SWG A, ETSI ERM, ETSI M2M, OGC, 3GPP, IETF, and XMPP
- TC 122 Liaison Officer to the International Telecommunications Union (ITU-R & ITU-T)
- Member representing ISO/TC 122 — JTC 1/SWG 5 (IoT), Liaison Officer to JCA-IoT
- Member representing ISO/TC 122 — IATA Cargo Wireless Technology Advisory Group
- Past Chair, ISO TC 122/104 Joint Working Group – Supply chain applications of RFID
- Chairman & Project Editor, ANS MH10.8.2 (Data Identifiers & Application Identifiers)
- Founder, ISO/IEC JTC 1/SC 31, *Automatic Identification and Data Capture Techniques*
- Vocabulary Rapporteur to ISO/IEC JTC 1/SC 31, ISO/IEC 19762 - *Harmonized vocabulary*
- Four time chair, U.S. TAG to ISO/IEC JTC 1/SC 31/WG 4 (RFID)
- Joint Automotive Industry Forum (JAMA/JAPIA/AIAG/ODETTE) – Returnable Transport Items & Item Level
- AIAG Bar Code, Applications, 2D, Tire, Returnables, & RFID Committees
- Founder, RFID Experts Group (REG)
- Member, EPCglobal HAG (UHFGen2), FMCG BAG, HLS BAG, SAG, TLS, TDS, AIWG, SBAC, HAT
- Organizer of the movement of IEEE 1451 (Sensors) and 802.15.4 (WPAN) to JTC 1/SC 31
- Original Project Editor, NATO STANAG 2233 (RFID for NATO Asset Tracking)
- CompTIA RFID Subject Matter Expert and RFID Certified Professional (CRCP) - RFID+
- Recipient of the 2004 Richard Dilling Award
- Author, *Reading Between The Lines — An Introduction to Bar Code Technology*
- President & CEO. Q.E.D. Systems, the leading AIDC consulting company for the past 33 years

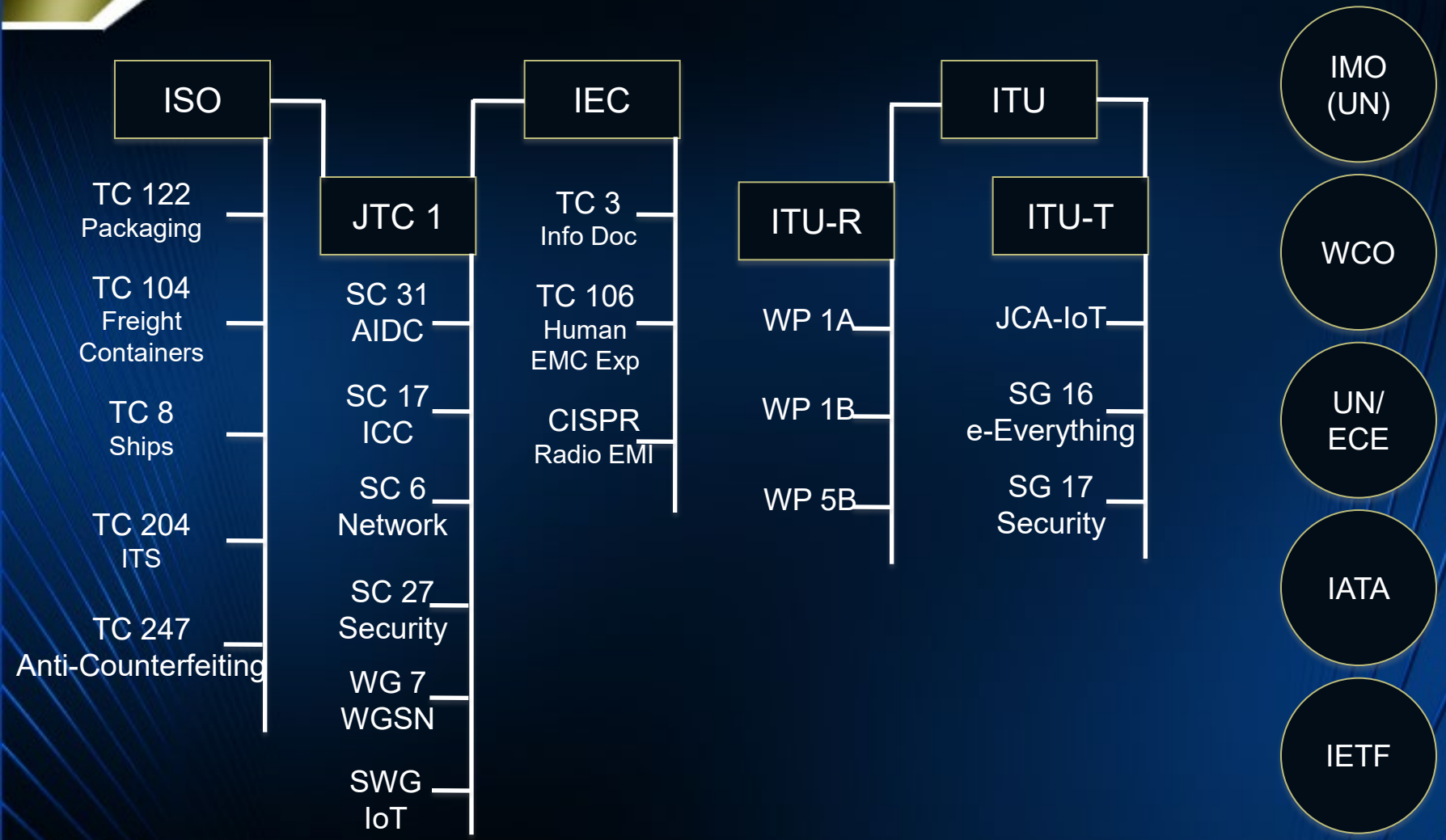

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# #8 . . . Cooperation

- IoT may very well be the next big new thing
- Whether called IoT, the Internet of Everything, M2M, or Cyber Physical Systems (CPS), there are many different names for similar or identical concepts
- ISO/IEC JTC 1 and ITU-T seem to be more interested in their individual efforts than in cooperation


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# International Activity that Affects You




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# #6
# Standardization


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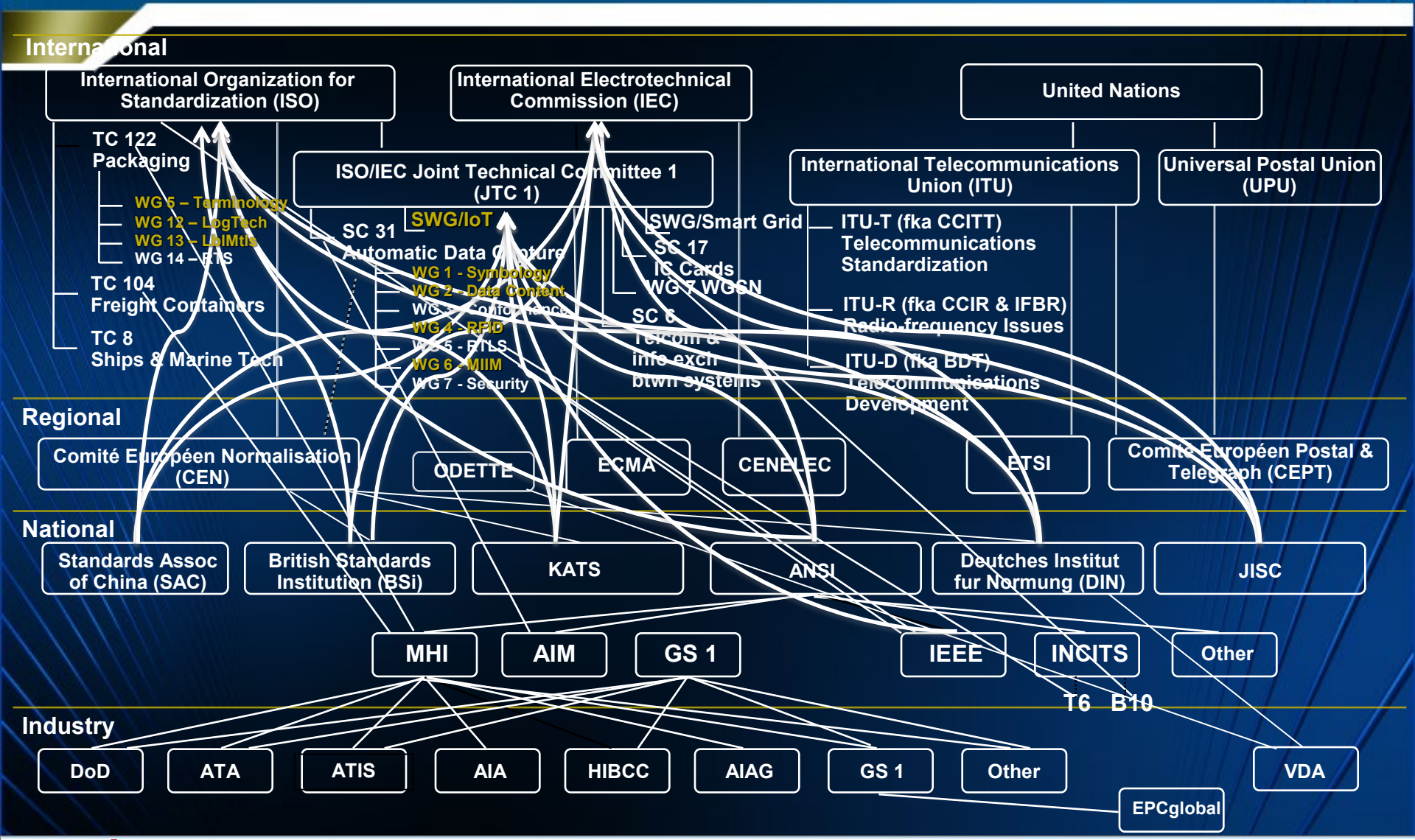
# Types of Standards

- **Technology**
  - Symbology, RFID, I.C. Card, Sensor
- **Data Content**
  - Semantics (DIs or AIs), Syntax, Unique Item Identification, Unique Device Identification
- **Conformance**
  - Print Quality, Test Specifications, Conformance to Air Interface
- **Network**
  - Object-to-object communications, Sensor Networks
- **Application Standards**
  - Freight container, Returnable Transport Item, Shipping Label, Product Package, Product Mark/Tag, eSeal, Access to web services


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# International Standards Activities

**There will be a short quiz at the end**






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# #5
# Data Content


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# #5 . . . Data Content

- Putting all of the disparate output from different devices into a manageable form
- Each device type follows its own unique data content standards


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# Use Cases – ISO 18575 – Products

**ISO 18575, *Internet of Things (IoT) in the supply chain — Products & product packages***
Read 2D symbol encoding URL: Identify destination resource URL, identify symbol, identify item, identify reader, identify read location, identify time of read, identify MAC address of connection to Internet, identify the person doing the reading

| Field | Header Name | Header Decimal | Header Hexadecimal | URN | Data |
|---|---|---|---|---|---|
| Identify destination resource address | IPv6 | 97 | 0x61 | urn:oid:1.0.29161.97 | http://www.sigmaaldrich.com/MSDS/MSDS/DisplayMSDSPage.do?country=US&language=en&productNumber=48599&brand=SUPELCO&PageToGoToURL |
| Identify media (QR Code symbol) | ]Q1 | - - - | - - - | - - - | ]Q1 |
| Identify item | UII (25S) | 73 | 0x49 | urn:oid:1.0.29161.73 | UN433257110123456789 |
| Identify read location | GPS ID (WGS 84) | 158 | 0x9E | urn:oid:1.0.29161.158 | 41.99869/-91.608037/237 |
| Identify time of read | UTC | 159 | 0x9F | urn:oid:1.0.29161.159 | 2013-03-22T19:33:51Z |
| Identify MAC address of connection to Internet | EUI-64 | 81 | 0x51 | urn:oid:1.0.29161.81 | 00127FFFFEEB6B40 |


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# Use Case – ISO 18577 – Transport Units

**ISO 18577, *Internet of Things (IoT) in the supply chain — Transport units***
Sensor threshold exceeded connected to RFID: Identify sensor, identify exceeded threshold, identify RF tag TID, identify item (UII) to which RF tag is attached, identify RF reader, identify destination resource address, identify read location, identify time of read, identify MAC address of connection to Internet

| Field | Header Name | Header Decimal | Header Hexadecimal | URN | Data |
|---|---|---|---|---|---|
| Identify destination resource address | IPv6 | 97 | 0x61 | urn:oid:1.0.29161.97 | 2001:0db8:85a3:0042:1000:8a2e:0370:7334 |
| Identify media (RFID) | ]Z2 | ]Z2 | ]Z2 | Not Used in XMPP | ]Q1 |
| Identify RF Tag ID per ISO/IEC 15963 | TagID | 157 | 0x9D | urn:oid:1.0.29161.157 | E02B800000000003 |
| Identify sensor | EUI-64 | 82 | 0x52 | urn:oid:1.0.29161.82 | ACDE48FFFE232567 |
| Sensor value | NONE | NONE | NONE | No 29161 Header | From 21451-7 (or other) |
| Identify item (UII) | Transport Unit (J) | 75 | 0x4B | urn:oid:1.0.29161.75 | UN433257110123456789 |
| Identify reader (MAC Address) | EUI-64 | 83 | 0x53 | urn:oid:1.0.29161.83 | 00127FFFFEEB6B40 |
| Identify read location | GPS ID (WGS 84) | 158 | 0x9E | urn:oid:1.0.29161.158 | 41.99869/-91.608037/237 |
| Identify time of read | UTC | 159 | 0x9F | urn:oid:1.0.29161.159 | 2013-03-22T19:33:51Z |


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# Use Case – ISO 18576 – RTIs

**ISO 18576, *Internet of Things (IoT) in the supply chain — Returnable transport items (RTIs)***
Sensor threshold exceeded connected to mobile device on 4G network: Identify sensor, identify exceeded threshold, identify item (UII) to which mobile device is attached, identify mobile device (IMEI), identify the SIM IC (ICCID), identify subscriber (IMSI), identify read location, identify time of read, identify MAC address of connection to Internet, identify destination resource address

| Field | Header Name | Header Decimal | Header Hexadecimal | URN | Data |
|---|---|---|---|---|---|
| Identify destination resource address | IPv6 | 97 | 0x61 | urn:oid:1.0.29161.97 | 2001:0db8:85a3:0042:1000:8a2e:0370:7334 |
| Identify sensor | EUI-64 | 82 | 0x52 | urn:oid:1.0.29161.82 | ACDE48FFFE232567 |
| Sensor value | --- | --- | --- | --- | From 21451-7 (or other) |
| Identify NCAP address of connection to Internet | EUI-64 (MAC) | 83 | 0x53 | urn:oid:1.0.29161.83 | 00127FFFFEEB6B40 |
| Identify port on NCAP/Gateway | --- | --- | --- | 1.0.29161.83.2 | 2 (urn:oid:1.0.29161.83.2) |
| Identify item | UII (25B) | 80 | 0x50 | urn:oid:1.0.29161.80 | UN433257110123456789 |
| Identify mobile device | IMEI | 177 | 0xB1 | urn:oid:1.0.29161.177 | 351451208401216 |
| Identify read location | GPS ID (WGS 84) | 158 | 0x9E | urn:oid:1.0.29161.158 | 41.99869/-91.608037/237 |
| Identify time of read | UTC | 159 | 0x9F | urn:oid:1.0.29161.159 | 2013-03-22T19:33:51Z |


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# Use Cases – ISO 18574 – Cargo

**ISO 18574**, ***Internet of Things (IoT) in the supply chain — Containerized cargo***
Sensor threshold exceeded connected on a network to a mobile device on 4G network: Identify sensor, identify exceeded threshold, identify item (UII) to which mobile device is attached, identify mobile device (IMEI), identify the SIM IC (ICCID), identify subscriber (IMSI), identify read location, identify time of read, identify MAC address of connection to Internet, identify destination resource address

| Field | Header Name | Header Decimal | Header Hexadecimal | URN | Data |
|---|---|---|---|---|---|
| Identify destination resource address | IPv6 | 97 | 0x61 | urn:oid:1.0.29161.97 | 2001:0db8:85a3:0042:1000:8a2e:0370:7334 |
| Identify sensor | EUI-64 | 82 | 0x52 | urn:oid:1.0.29161.82 | ACDE48FFFE232567 |
| Sensor value | --- | --- | --- | --- | From 21451-7 (or other) |
| Identify NCAP address of connection to Internet | EUI-64 (MAC) | 83 | 0x53 | urn:oid:1.0.29161.83 | 00127FFFFEEB6B40 |
| Identify port on NCAP/Gateway | --- | --- | --- | 1.0.29161.83.2 | 2 (urn:oid:1.0.29161.83.2) |
| Identify item | UII (7B) | 81 | 0x51 | urn:oid:1.0.29161.81 | AAA A NNNNNN N |
| Identify mobile device | IMEI | 177 | 0xB1 | urn:oid:1.0.29161.177 | 351451208401216 |
| Identify read location | GPS ID (WGS 84) | 158 | 0x9E | urn:oid:1.0.29161.158 | 41.99869/-91.608037/237 |
| Identify time of read | UTC | 159 | 0x9F | urn:oid:1.0.29161.159 | 2013-03-22T19:33:51Z |


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# #4

# Representation of Location and Time


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# #4 . . . Defining Time & Location

= 1397049300


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# #4 . . . Defining Time & Location

= 2014-04-09T13:15:00Z


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# #4 . . . Defining Time & Location

- Two competing methods
  - Epoch time – Number of seconds that have elapsed since 00:00:00 Coordinated Universal Time (UTC), Thursday, 1 January 1970, not including leap seconds
    = 1397049300
  - ✓UTC (Coordinated Universal Time) (ISO 8601)
    = 2014-04-09T13:15:00Z


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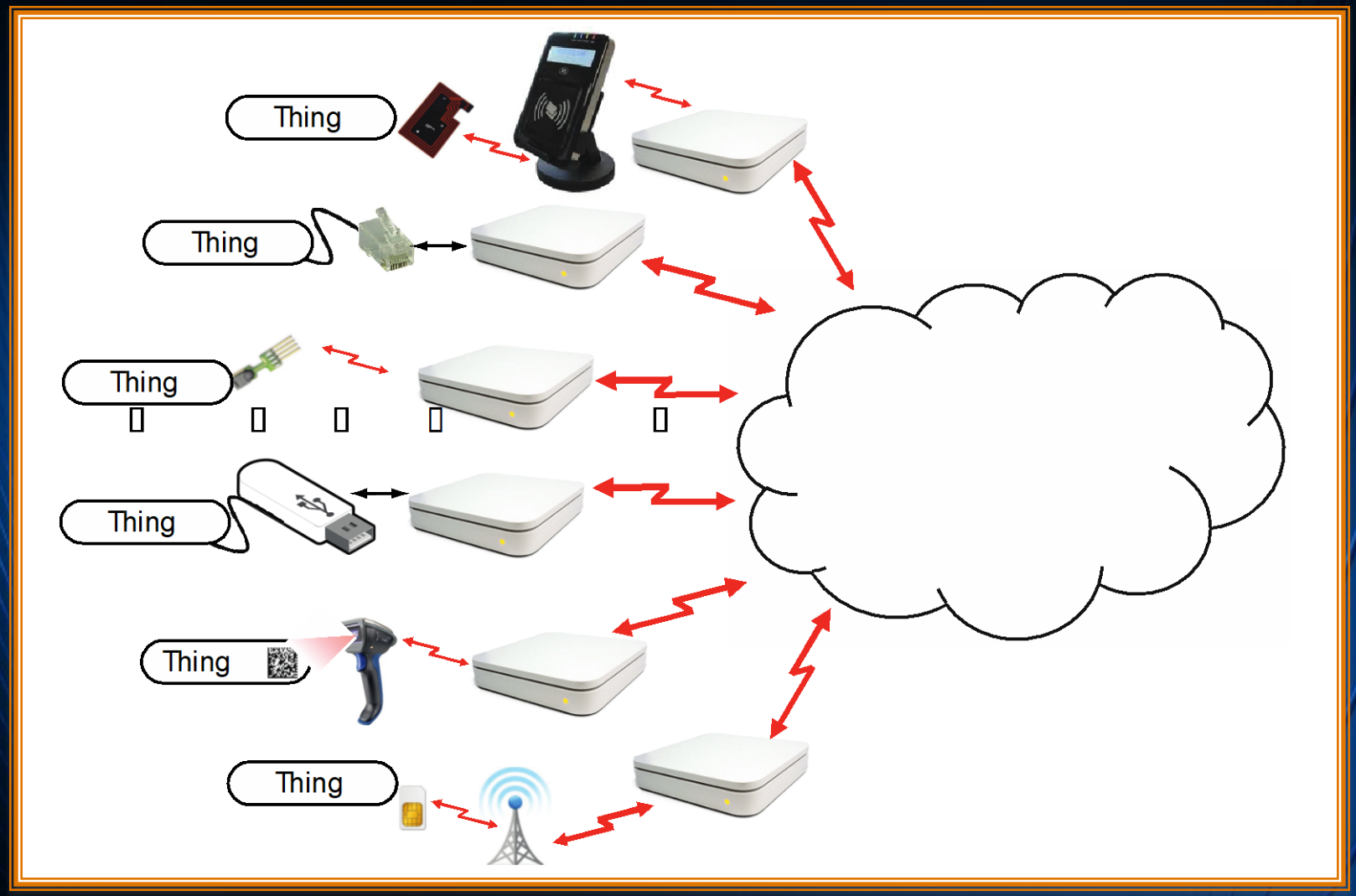
# Location – ANS MH10.8.2

One degree is equivalent to approximately 110 000 meters, depending upon one's location on the earth where, because of its spheroid shape, a degree is of greater distance at the equator than at the poles. Degrees can be reduced to minutes (1/60$^{th}$ of a degree) and then seconds (1/60$^{th}$ of a minute) to where a second of latitude or longitude is approximately 30.56 meters. Likewise, we can decimally represent a portion of a meter where to six significant digits one can get to a resolution of 0.11 meters. Secondly, many representations of latitude and longitude include either a North / South designation for latitude and an East / West designation for longitude. Alternately, some designations of South latitude and West longitude are differentiated from their North and East counterparts by a "-" (minus) prefix. Further, there are 360 degrees of longitude from 180° to -180° and 180 degrees of latitude from 90° to -90° . Also, the tallest building in 2012 is 828 meters, though plans do exist for structures greater than 1 000 meters in height. Finally, there are locations that exist below sea level, so a minus (-) is also required for altitude.

Consequently, the format recommended by this standard for Latitude / Longitude / Altitude is xnn.nnnnn/xnnn.nnnnnn/xnnnn is in a range of 5 (intersection of the Prime Meridian with the Equator - n/n/n) to 27 characters (xnn.nnnnn/xnnn.nnnnnn/xnnnn). The "x" value is to permit the inclusion of a "-" (minus) prefix for South latitudes and West longitudes. The "-" (minus) prefix, "." (decimal point), and "/" solidus are explicitly encoded.


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# To Which "Thing" are We Referring





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# ISO/IEC 29161 – Unique Identification

- Builds on EPC header system
- Being developed in JTC 1/SC 31/WG 2
- Will be completed in either JTC 1/SC 31/WG 2 or ISO/TC 122


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# Object Identifier Registration Tree

| itu-t (0) | | iso (1) | | joint-iso-itu-t (2) | |
|---|---|---|---|---|---|
| recommendation | (0) | standard | (0) | module | (1) |
| question | (1) | registration-authority | (1) | document-types | (2) |
| administration | (2) | member-body | (2) | asn.1 | (3) |
| network-operator | (3) | identified-organization | (3) | reserved | (4) |
| identified-organization | (4) | | | international md | (5) |
| r-recommendation | (5) | | | international organization | (6) |
| data | (9) | | | | |

EXAMPLE for ISO/IEC 29161 : 1.0.29161
EXAMPLE for ISO/IEC 29161 Header 82 (EUI-64 Sensor ID) : 1.0.29161.82
Expressed as a URN : urn:oid:1.0.29161.82

NOTE 1 OID Registration Tree defined in ITU-T X.660 and ISO/IEC 9834
NOTE 2 URN OID defined in IETF RFC 3061


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# Unique ID Header Values

| Header (binary) | Header (0xnn) | Header (decimal) | Significance | OID |
|---|---|---|---|---|
| 0000 0000 | 0 | 0 | Unprogrammed media | urn:oid:1.0.29161.0 |
| 0100 0001 | 41 | 65 | ISO UII Product (n) | urn:oid:1.0.29161.65 |
| 0100 0010 | 42 | 66 | ISO UII Transport Unit (n) | urn:oid:1.0.29161.66 |
| 0100 0011 | 43 | 67 | ISO UII RTI (n) | urn:oid:1.0.29161.67 |
| 0100 0100 | 44 | 68 | ISO UII Containerized Cargo () | urn:oid:1.0.29161.68 |
| 0100 0101 | 45 | 69 | ISO UII Product (an) | urn:oid:1.0.29161.69 |
| 0100 0110 | 46 | 70 | ISO UII Transport Unit (an) | urn:oid:1.0.29161.70 |
| 0100 0111 | 47 | 71 | ISO UII RTI (an) | urn:oid:1.0.29161.71 |
| 0100 1000 | 48 | 72 | ISO UII Containerized Cargo (an) | urn:oid:1.0.29161.72 |
| 0100 1001 | 49 | 73 | ISO UII Product & Product Package (25S) | urn:oid:1.0.29161.73 |
| 0100 1010 | 4A | 74 | ISO UII Product & Product Package (37S) | urn:oid:1.0.29161.74 |
| 0100 1011 | 4B | 75 | ISO UII Transport Unit (J) | urn:oid:1.0.29161.75 |
| 0100 1100 | 4C | 76 | ISO UII Transport Unit (1J) | urn:oid:1.0.29161.76 |
| 0100 1101 | 4D | 77 | ISO UII Transport Unit (2J) | urn:oid:1.0.29161.77 |
| 0100 1110 | 4E | 78 | ISO UII Transport Unit (5J) | urn:oid:1.0.29161.78 |
| 0100 1111 | 4F | 79 | ISO UII Transport Unit (6J) | urn:oid:1.0.29161.79 |
| 0101 0000 | 50 | 80 | ISO UII Returnable Transport Item (25B) | urn:oid:1.0.29161.80 |
| 0101 0001 | 51 | 81 | UII Containerized Cargo (7B) | urn:oid:1.0.29161.81 |
| 0101 0010 | 52 | 82 | EUI-64 Sensor ID | urn:oid:1.0.29161.82 |
| 0101 0011 | 53 | 83 | EUI-64 MAC Address | urn:oid:1.0.29161.83 |
| 0101 0100 | 54 | 84 | EUI-64 802.15.4 ID | urn:oid:1.0.29161.84 |


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# Unique ID Header Values

| Header (binary) | Header (0xnn) | Header (decimal) | Significance | OID |
|---|---|---|---|---|
| 0101 1001 | 59 | 89 | NII – 7812-1 | urn:oid:1.0.29161.89 |
| 0101 1010 | 5A | 90 | NII - 15459 | urn:oid:1.0.29161.90 |
| 0101 1011 | 5B | 91 | NII - 3166 | urn:oid:1.0.29161.91 |
| 0101 1100 | 5C | 92 | MII Construct 1 (ISO/IEC 29174-1) | urn:oid:1.0.29161.92 |
| 0101 1101 | 5D | 93 | MII Construct 2 (ISO/IEC 29174-1) | urn:oid:1.0.29161.93 |
| 0101 1110 | 5E | 94 | MII Construct 3 (ISO/IEC 29174-1) | urn:oid:1.0.29161.94 |
| 0101 1111 | 5F | 95 | MII Construct 4 (ISO/IEC 29174-1) | urn:oid:1.0.29161.95 |
| 0110 0001 | 61 | 97 | IPv6 | urn:oid:1.0.29161.97 |
| 0111 0001 | 71 | 113 | E.164 (MSISDN) | urn:oid:1.0.29161.113 |
| 1000 0001 | 81 | 129 | IMSI (E.212) | urn:oid:1.0.29161.129 |
| 1000 0010 | 82 | 130 | ICCID | urn:oid:1.0.29161.130 |
| 1000 1111 | 8F | 143 | Jabber ID | urn:oid:1.0.29161.143 |
| 1001 1101 | 9D | 157 | TagID | urn:oid:1.0.29161.157 |
| 1001 1110 | 9E | 158 | GPS ID (WGS 84) | urn:oid:1.0.29161.158 |
| 1001 1111 | 9F | 159 | UTC | urn:oid:1.0.29161.159 |
| 1011 0001 | B1 | 177 | IMEI | urn:oid:1.0.29161.177 |
| 1101 0001 | D1 | 209 | IPv4 | urn:oid:1.0.29161.209 |
| 1111 0001 | F1 | 241 | ITU-T H.642/uCode UII | urn:oid:1.0.29161.241 |
| 1111 1111 | FF | 255 | Reserved for Extensibility | urn:oid:1.0.29161.255 |


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# #3
# Unique Identification


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# #3 . . . Unique Identification

*I have six honest serving men*

*They taught me all I knew*

*Their names are What, and Where and When;*

*and Why and How and Who.*

*- Rudyard Kipling (1865-1936)*

**With apologies to the celebrated English poet and author, the supply chain submits that a seventh honest man is missing whose name is "Which".**

**And, as in Macbeth, there are three "Whiches":**

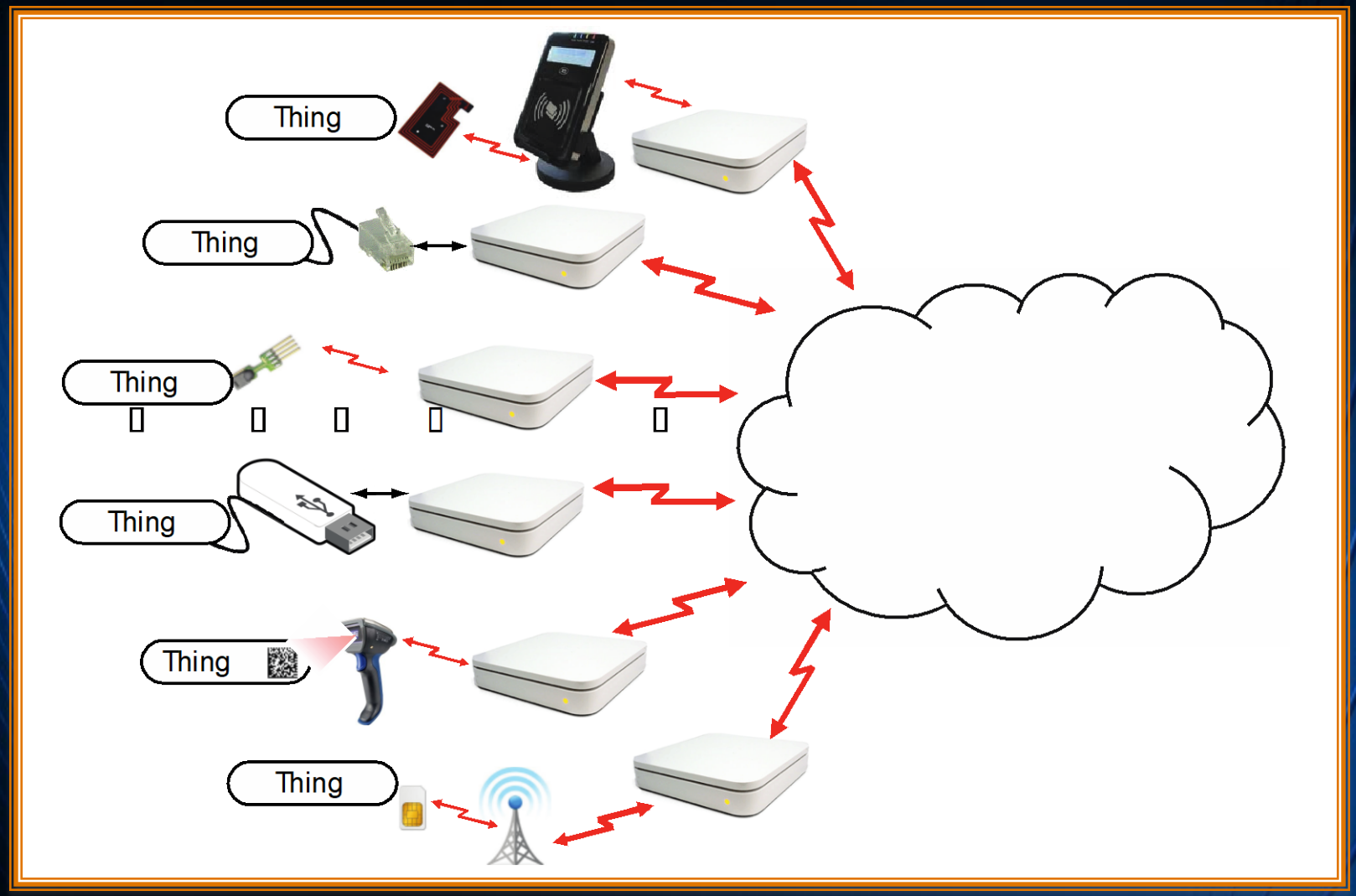
- **"Which one",**
- **"Which group",**
- **"Which transport unit".**

**For these seven "questions" underpin the very heart of the supply chain, traceability, tracking, and chain of custody.**

| | | |
|---|---|---|
| WHO | Individual | Identification of the individual |
| WHAT | Product code | Identification of the product (SKU) |
| WHICH (Item) | Unique item | Globally unique item serial number |
| WHICH (Group) | Specific group | Identification of the lot or batch |
| WHICH (Container) | Package ID | Globally unique transport unit identifier |
| WHERE | Location (Storage/Postal/ Lat Long Alt) | Unambiguous identification of the location |
| WHEN | At what time | Unambiguous time stamp |
| HOW | Method | Unambiguous identification of the process |
| WHY | Authority | Purchase Order/ Work Order |


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# To Which "Thing" are We Referring





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# ISO/IEC 29161 – Unique Identification

- Builds on EPC header system
- Currently being developed in JTC 1/SC 31/WG 2
- Will be completed in either JTC 1/SC 31/WG 2 or ISO/TC 122


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# Object Identifier Registration Tree

| itu-t (0) | | iso (1) | | joint-iso-itu-t (2) | |
|---|---|---|---|---|---|
| recommendation | (0) | standard | (0) | module | (1) |
| question | (1) | registration-authority | (1) | document-types | (2) |
| administration | (2) | member-body | (2) | asn.1 | (3) |
| network-operator | (3) | identified-organization | (3) | reserved | (4) |
| identified-organization | (4) | | | international md | (5) |
| r-recommendation | (5) | | | international organization | (6) |
| data | (9) | | | | |

EXAMPLE for ISO/IEC 29161 : 1.0.29161
EXAMPLE for ISO/IEC 29161 Header 82 (EUI-64 Sensor ID) : 1.0.29161.82
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| 0100 0010 | 42 | 66 | ISO UII Transport Unit (n) | urn:oid:1.0.29161.66 |
| 0100 0011 | 43 | 67 | ISO UII RTI (n) | urn:oid:1.0.29161.67 |
| 0100 0100 | 44 | 68 | ISO UII Containerized Cargo () | urn:oid:1.0.29161.68 |
| 0100 0101 | 45 | 69 | ISO UII Product (an) | urn:oid:1.0.29161.69 |
| 0100 0110 | 46 | 70 | ISO UII Transport Unit (an) | urn:oid:1.0.29161.70 |
| 0100 0111 | 47 | 71 | ISO UII RTI (an) | urn:oid:1.0.29161.71 |
| 0100 1000 | 48 | 72 | ISO UII Containerized Cargo (an) | urn:oid:1.0.29161.72 |
| 0100 1001 | 49 | 73 | ISO UII Product & Product Package (25S) | urn:oid:1.0.29161.73 |
| 0100 1010 | 4A | 74 | ISO UII Product & Product Package (37S) | urn:oid:1.0.29161.74 |
| 0100 1011 | 4B | 75 | ISO UII Transport Unit (J) | urn:oid:1.0.29161.75 |
| 0100 1100 | 4C | 76 | ISO UII Transport Unit (1J) | urn:oid:1.0.29161.76 |
| 0100 1101 | 4D | 77 | ISO UII Transport Unit (2J) | urn:oid:1.0.29161.77 |
| 0100 1110 | 4E | 78 | ISO UII Transport Unit (5J) | urn:oid:1.0.29161.78 |
| 0100 1111 | 4F | 79 | ISO UII Transport Unit (6J) | urn:oid:1.0.29161.79 |
| 0101 0000 | 50 | 80 | ISO UII Returnable Transport Item (25B) | urn:oid:1.0.29161.80 |
| 0101 0001 | 51 | 81 | UII Containerized Cargo (7B) | urn:oid:1.0.29161.81 |
| 0101 0010 | 52 | 82 | EUI-64 Sensor ID | urn:oid:1.0.29161.82 |
| 0101 0011 | 53 | 83 | EUI-64 MAC Address | urn:oid:1.0.29161.83 |
| 0101 0100 | 54 | 84 | EUI-64 802.15.4 ID | urn:oid:1.0.29161.84 |


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| 0101 1100 | 5C | 92 | MII Construct 1 (ISO/IEC 29174-1) | urn:oid:1.0.29161.92 |
| 0101 1101 | 5D | 93 | MII Construct 2 (ISO/IEC 29174-1) | urn:oid:1.0.29161.93 |
| 0101 1110 | 5E | 94 | MII Construct 3 (ISO/IEC 29174-1) | urn:oid:1.0.29161.94 |
| 0101 1111 | 5F | 95 | MII Construct 4 (ISO/IEC 29174-1) | urn:oid:1.0.29161.95 |
| 0110 0001 | 61 | 97 | IPv6 | urn:oid:1.0.29161.97 |
| 0111 0001 | 71 | 113 | E.164 (MSISDN) | urn:oid:1.0.29161.113 |
| 1000 0001 | 81 | 129 | IMSI (E.212) | urn:oid:1.0.29161.129 |
| 1000 0010 | 82 | 130 | ICCID | urn:oid:1.0.29161.130 |
| 1000 1111 | 8F | 143 | Jabber ID | urn:oid:1.0.29161.143 |
| 1001 1101 | 9D | 157 | TagID | urn:oid:1.0.29161.157 |
| 1001 1110 | 9E | 158 | GPS ID (WGS 84) | urn:oid:1.0.29161.158 |
| 1001 1111 | 9F | 159 | UTC | urn:oid:1.0.29161.159 |
| 1011 0001 | B1 | 177 | IMEI | urn:oid:1.0.29161.177 |
| 1101 0001 | D1 | 209 | IPv4 | urn:oid:1.0.29161.209 |
| 1111 0001 | F1 | 241 | ITU-T H.642/uCode UII | urn:oid:1.0.29161.241 |
| 1111 1111 | FF | 255 | Reserved for Extensibility | urn:oid:1.0.29161.255 |


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# #1

# Telecommunications


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# #1 . . . Telecommunications

- Near Field Communications (NFC)
- Wireless Personal Area Networks (WPAN)
  - ISO/IEC/IEEE 802.15
    - ZigBee
    - Bluetooth
- Local Area Networks (LAN)
  - WiFi
  - ISO/IEC/IEEE 802.11
  - RFID networks
- Wireless Wide Area Networks (WWAN)
  - 2G, 3G, 4G, LTE, 5G


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# 4G Bands

- North America: 700, 850, 1900, 1700/2100 and 2600 MHz are used (bands 4, 7, 12, 13, 17, 25, 26, 41)
- South America: 2500 MHz
- Europe: 800, 900, 1800, 2600 MHz in (bands 3, 7, 20)
- Asia: 1800 and 2600 MHz (bands 1, 3, 5, 7, 8, 11, 13, 40)
- Australia: 1800 MHz
- New Zealand: 2300 MHz (bands 3, 40)


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# 5G

- The 5G-Infrastructure-PPP is a 1.4 Billion Euro joint initiative between the European ICT industry and the European Commission to rethink the infrastructure and to create the Next generation of communication networks and services that will provide ubiquitous super-fast connectivity and seamless service delivery in all circumstances


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# 5GPP

- The development of new communication networks is dependent on the emergence of globally accepted standards in order to ensure interoperability, economies of scale with affordable cost for system deployment and end users. This partnership aims to have European industry driving the development of 5G standards and to develop and exploit at least 20% of the 5G SEP (standards essential patents).


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# ???


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# Thank you!!!

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