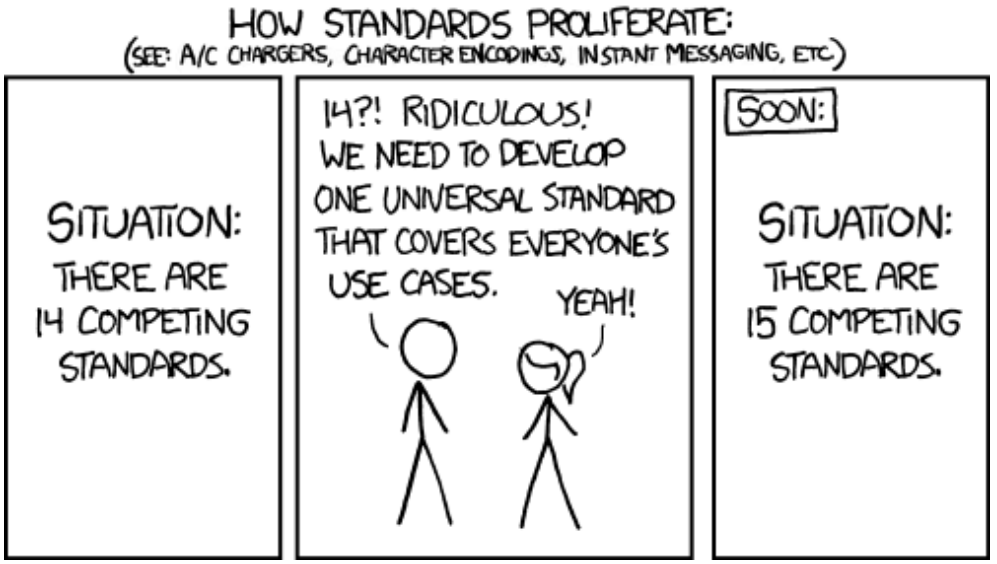
IoT Roadmap in the IETF

Ines Robles

2016

Agenda

- IETF and IoT Definitions
- IETF IoT WGs
  - Internet Area: 6lo, 6tisch, lpwan, lwig
  - Routing Area: ROLL
  - Application and Real Time Area: core
  - Security Area: ace
- IRTF IoT WG: t2trg
- Conclusions


HOW STANDARDS PROLIFERATE:
(SEE: A/C CHARGERS, CHARACTER ENCODINGS, INSTANT MESSAGING, ETC.)
SITUATION:
THERE ARE
14 COMPETING
STANDARDS.
14?! RIDICULOUS!
WE NEED TO DEVELOP
ONE UNIVERSAL STANDARD
THAT COVERS EVERYONE'S
USE CASES.
YEAH!
SOON:
SITUATION:
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Handbook: Internet of Things Alliances and Consortia

The goal of the The Internet Engineering Task Force (IETF)

is to make the Internet work better → developing protocols

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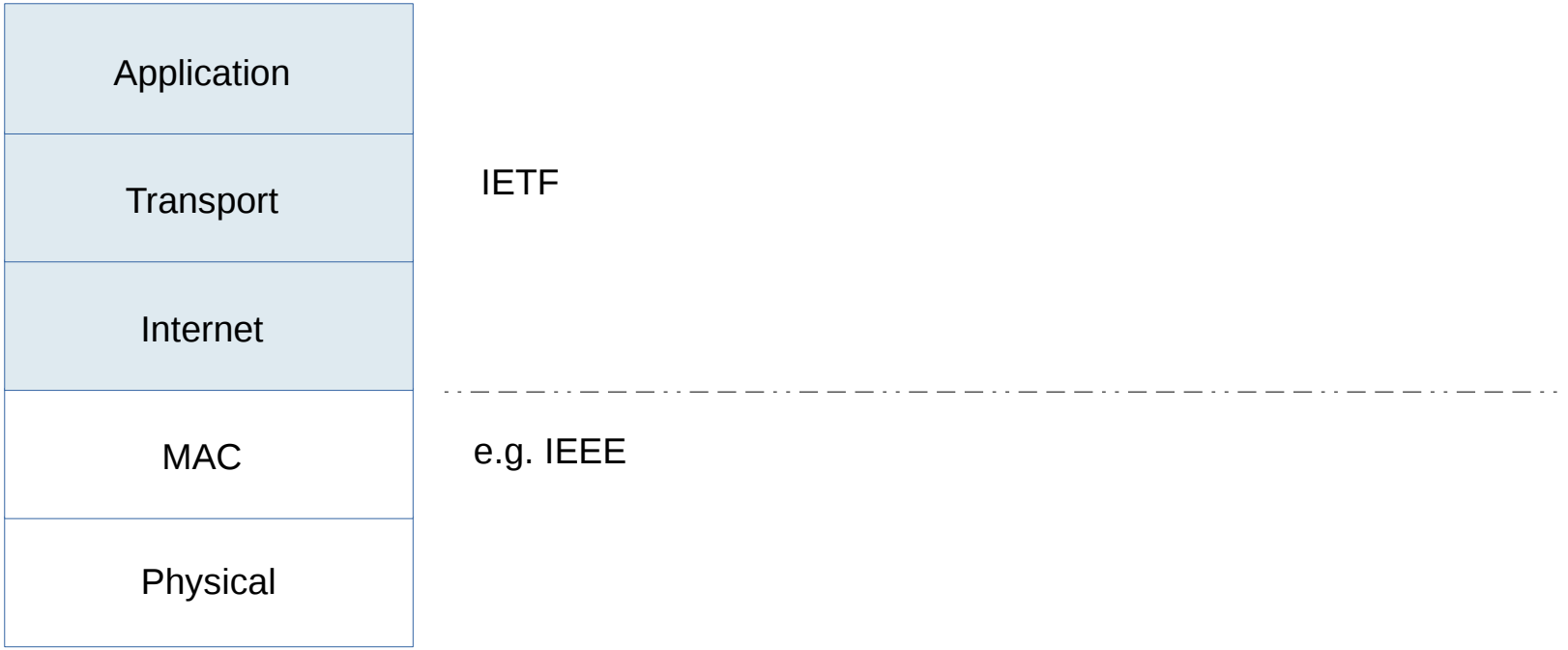

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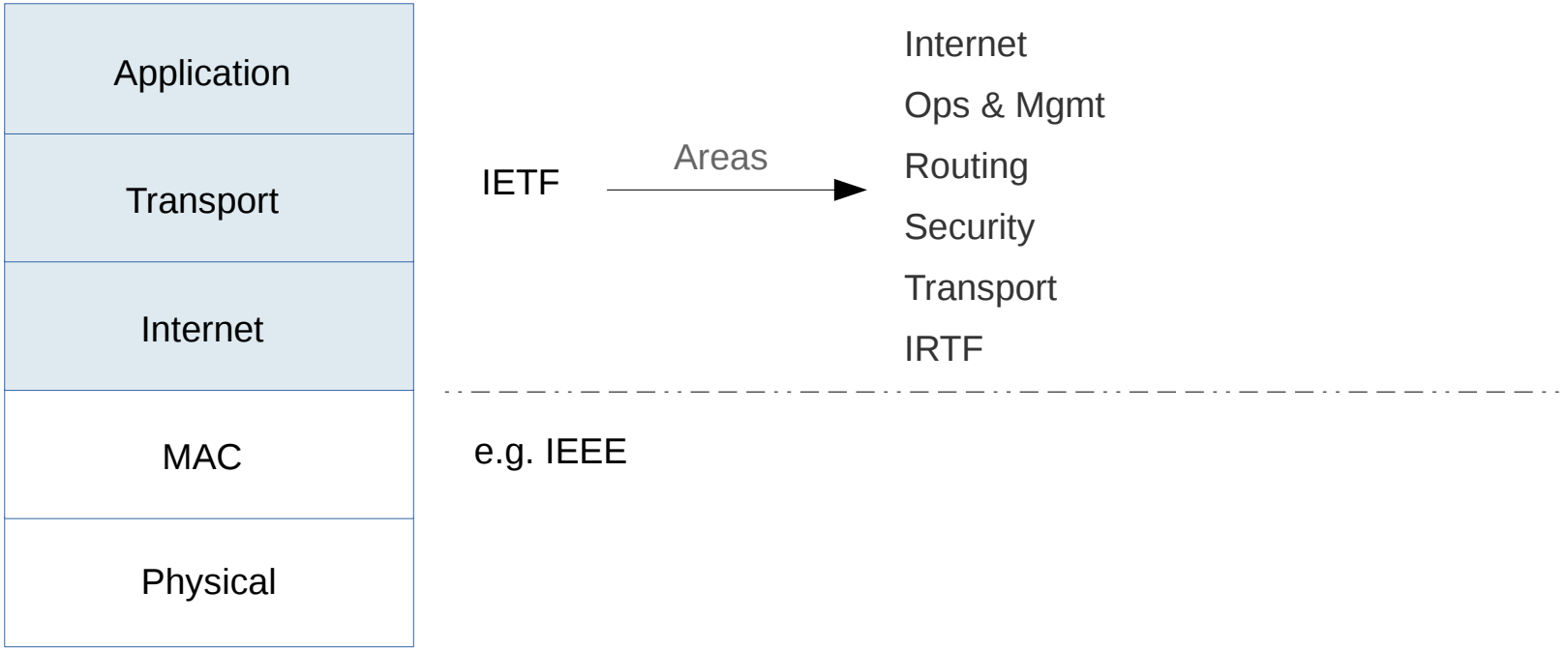

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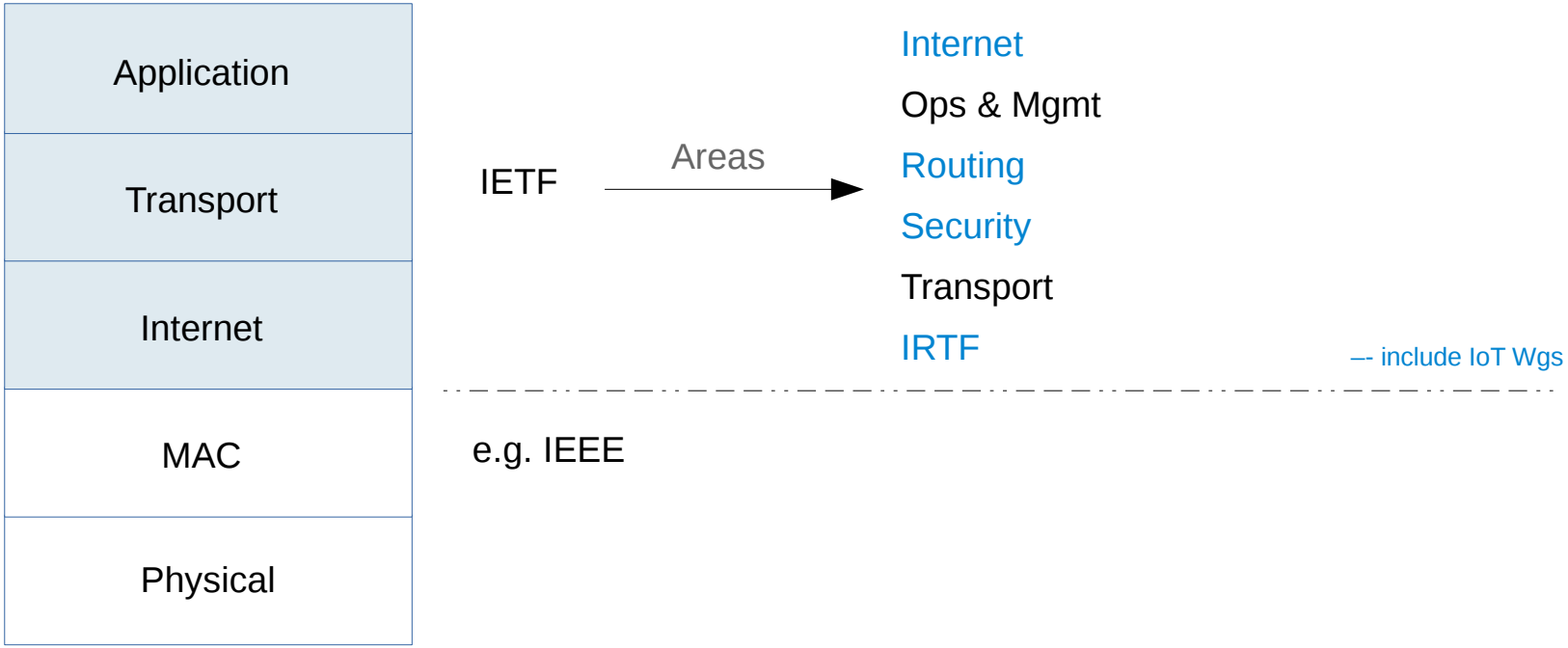

IoT(Internet of Things)

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Adapt the Internet to different types of networks

e.g. constrained networks/nodes

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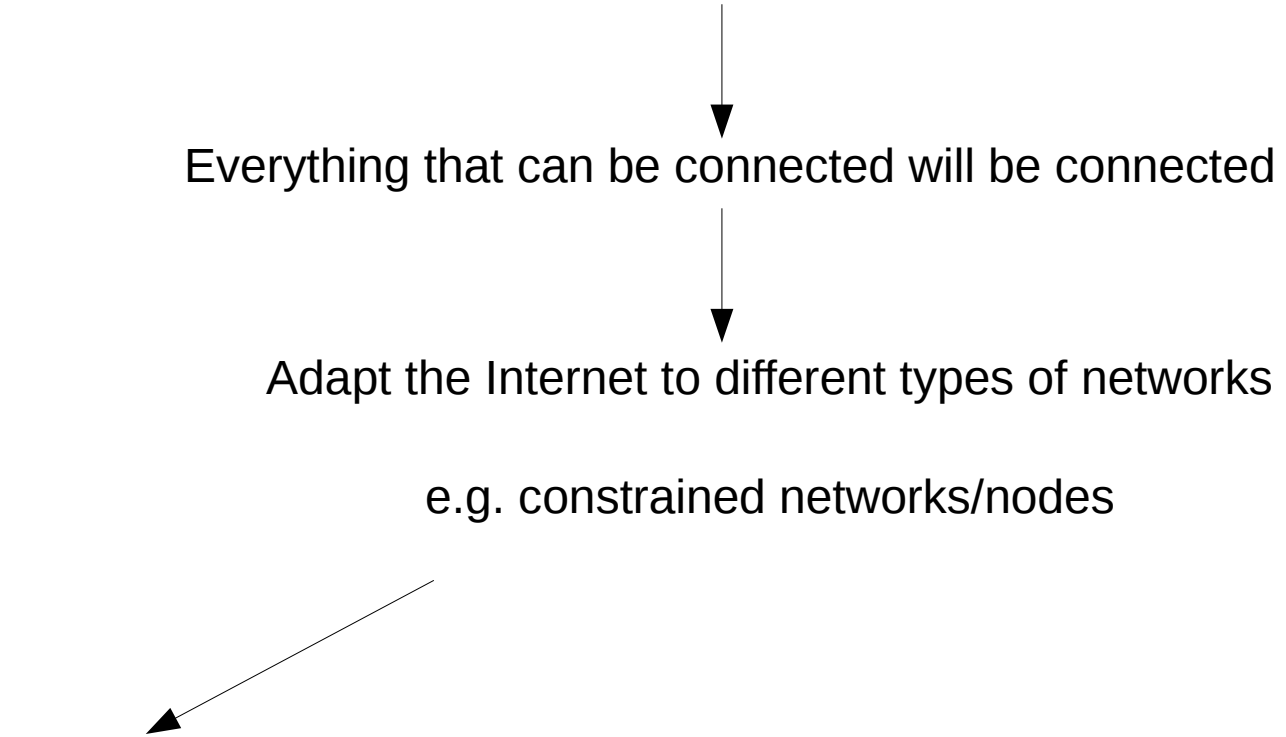

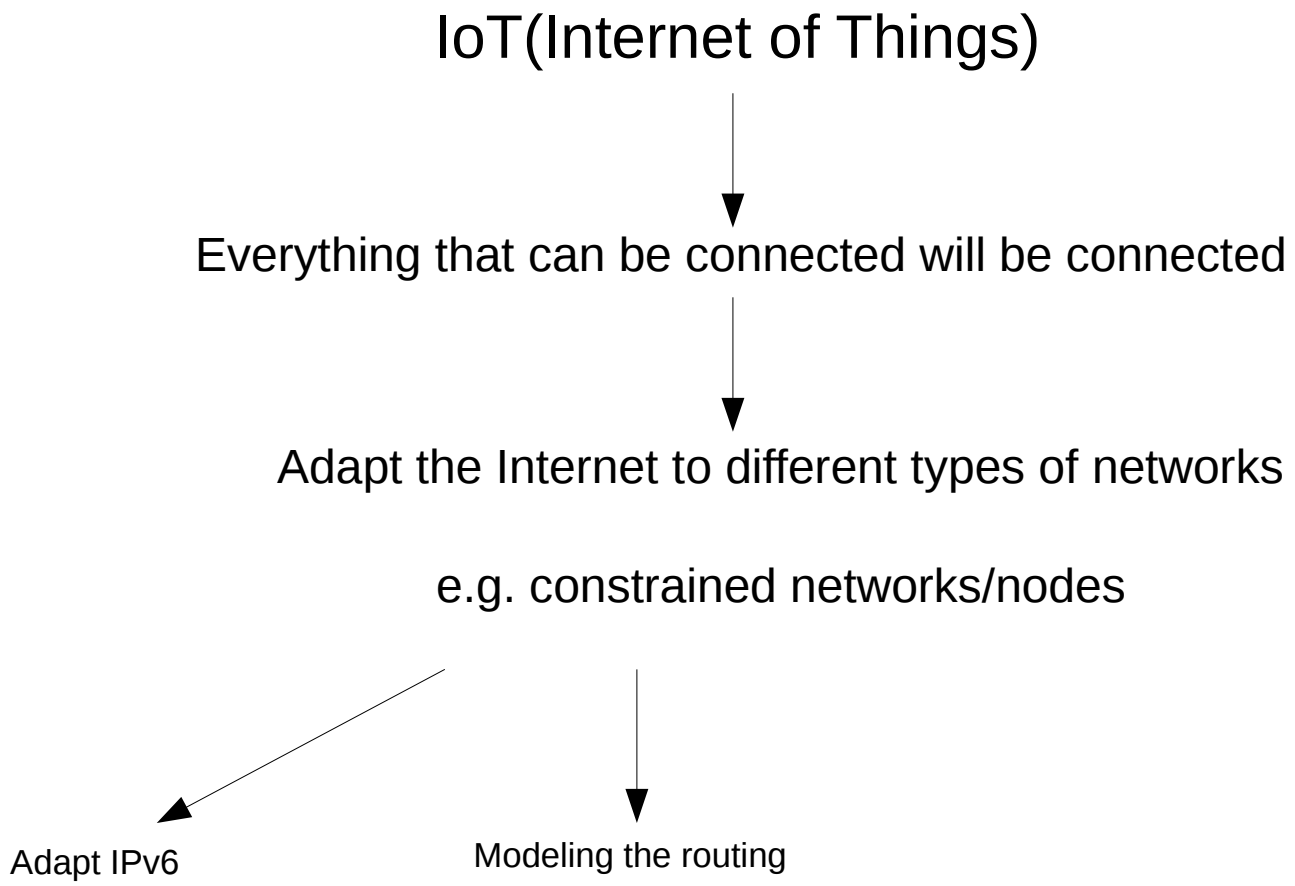
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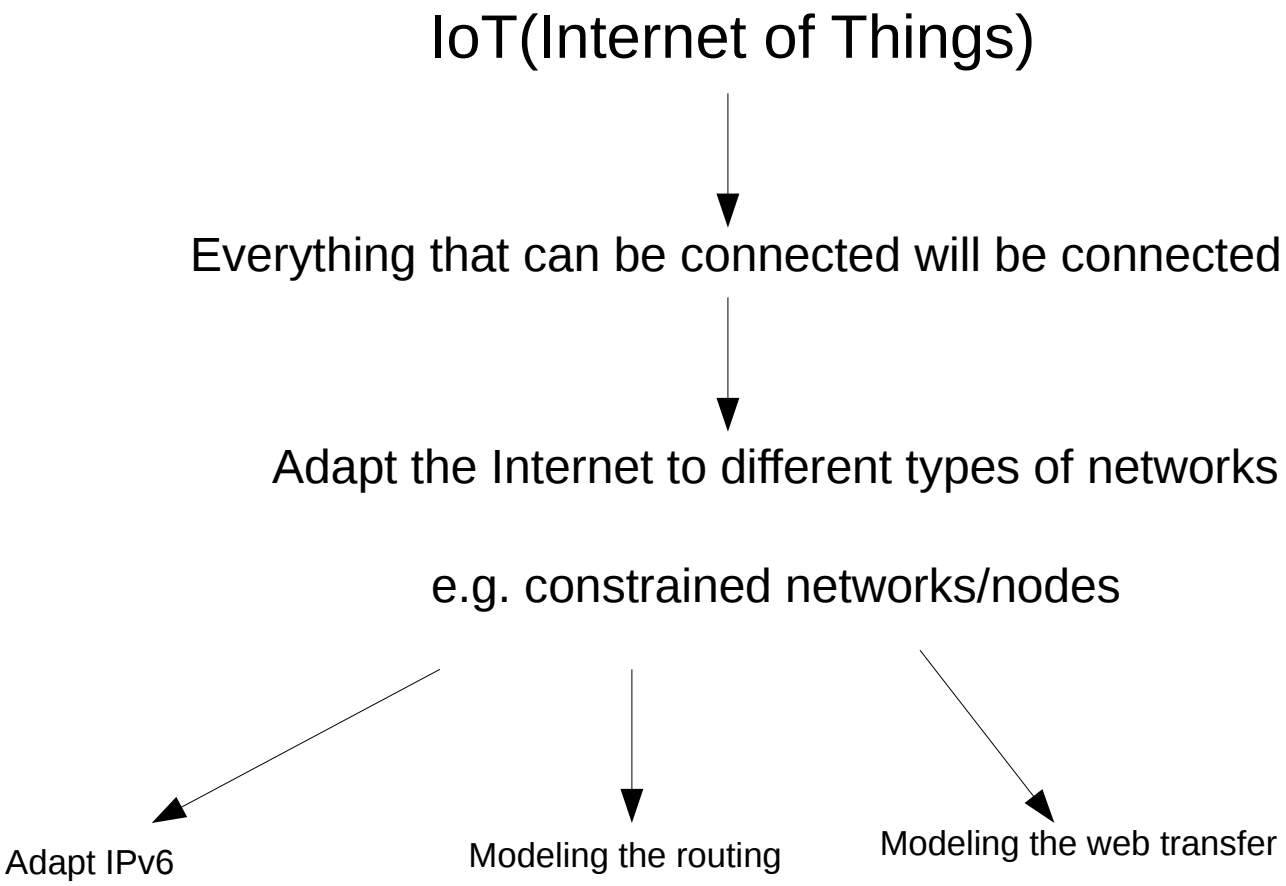
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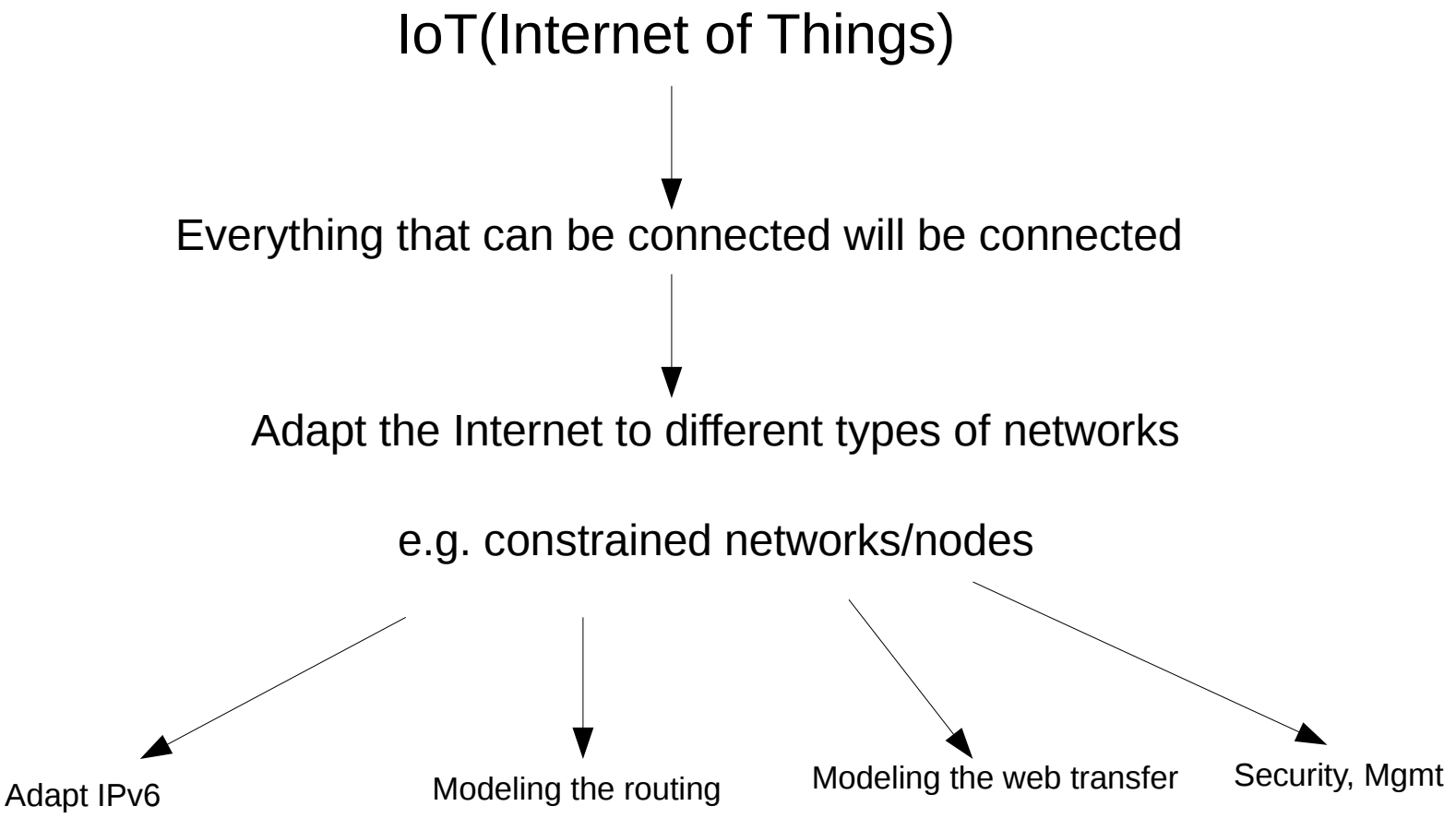
Modeling the web transfer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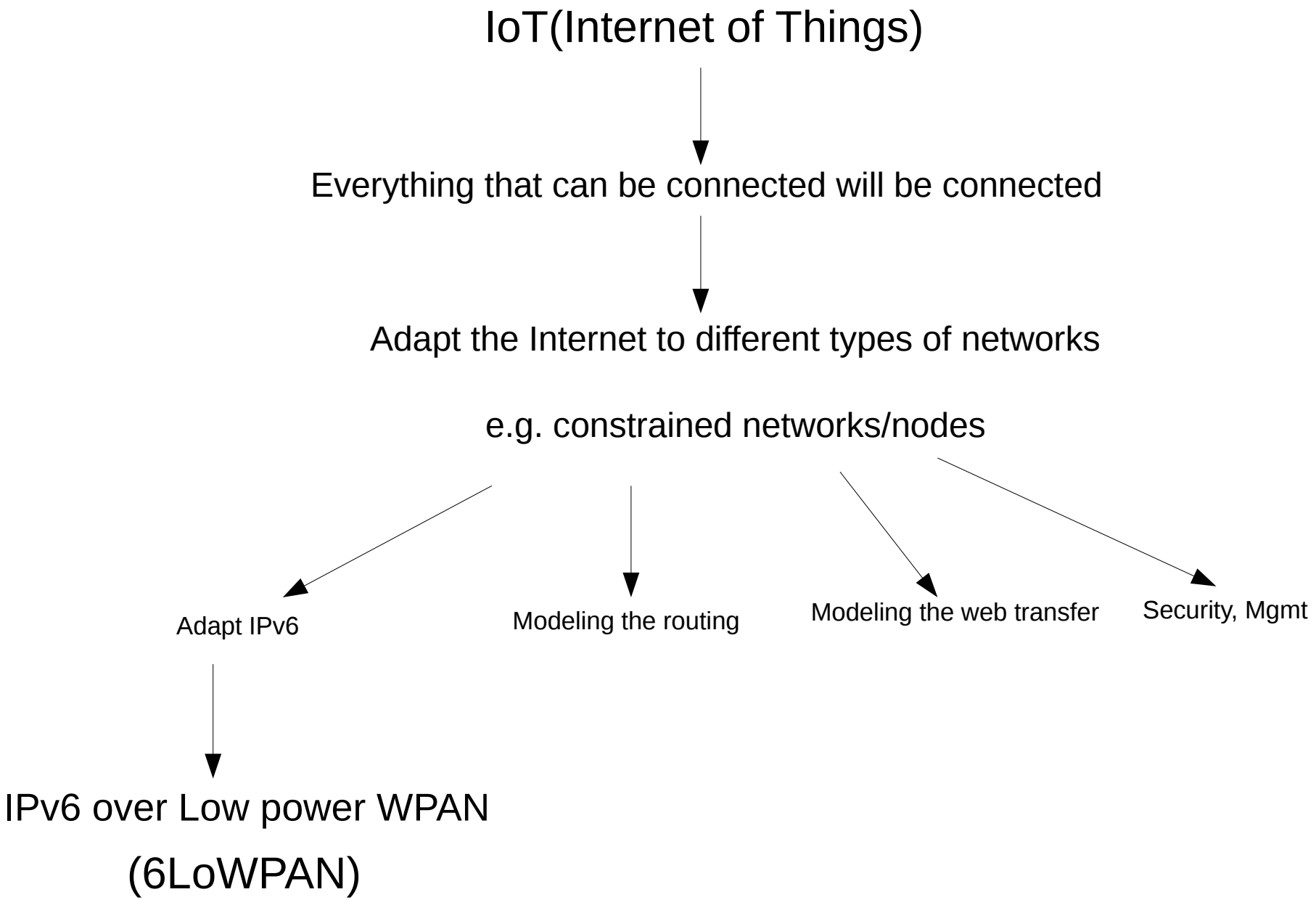
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IPv6 over Low power WPAN
(6LoWPAN)

IPv6 over Low power WPAN (6lowpan) aims to compress the IPv6 header

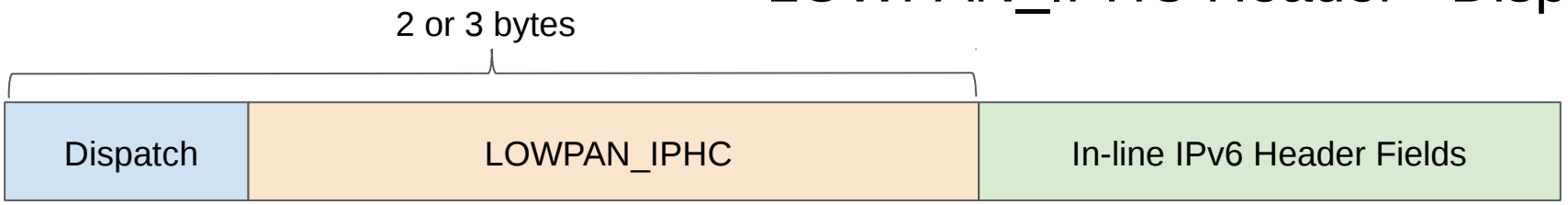
Developed for 802.15.4 networks

RFC 4944 defines a first version (LOWPAN_HC1) => not efficient

RFC 6282 defines

- IPv6 Header Compression (LOWPAN_IPHC)
- IPv6 Next Header Compression (LOWPAN_NHC)
  - e.g UDP.

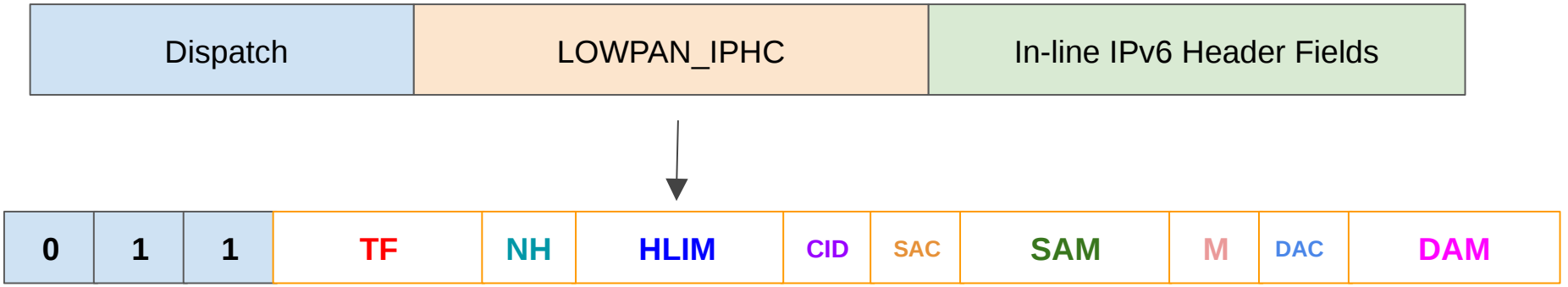
LOWPAN_IPHC Header - Dispatch



Bit Pattern	Page	Header Type	Reference
00 xxxxxx	0	NALP	[RFC4944][RFC-ietf-6lo-paging-dispatch-05]
00 xxxxxx	1-14	Unassigned	
00 xxxxxx	15	Reserved	[RFC-ietf-6lo-paging-dispatch-05]
01 000000	0	ESC	[RFC6282]
01 000000	1-14	Unassigned	
01 000000	15	Reserved	[RFC-ietf-6lo-paging-dispatch-05]
01 000001	0	IPv6 - uncompressed IPv6 Addresses	[RFC4944][RFC-ietf-6lo-paging-dispatch-05]
01 000001	1-14	Unassigned	
01 000001	15	Reserved	[RFC-ietf-6lo-paging-dispatch-05]
01 000010	0	LOWPAN_HC1 - LOWPAN_HC1 compressed IPv6	[RFC4944][RFC-ietf-6lo-paging-dispatch-05]
01 000010	1-14	Unassigned	
01 000010	15	Reserved	[RFC-ietf-6lo-paging-dispatch-05]
01 000011	0	LOWPAN_DFF	[RFC6971][RFC-ietf-6lo-paging-dispatch-05]
01 000011	1-14	Unassigned	
01 000011	15	Reserved	[RFC-ietf-6lo-paging-dispatch-05]
01 000100 through 01 001111	0-14	Unassigned	
01 000100 through 01 001111	15	Reserved	[RFC-ietf-6lo-paging-dispatch-05]
01 010000	0	LOWPAN_BC0 - LOWPAN_BC0 broadcast	[RFC4944][RFC-ietf-6lo-paging-dispatch-05]
01 010000	1-14	Unassigned	
01 010000	15	Reserved	[RFC-ietf-6lo-paging-dispatch-05]
01 010001 through 01 011111	0-14	Unassigned	
01 010001 through 01 011111	15	Reserved	[RFC-ietf-6lo-paging-dispatch-05]
01 1xxxxx	0-1	LOWPAN_IPHC	[RFC6282][RFC-ietf-6lo-paging-dispatch-05]
01 1xxxxx	2-14	Unassigned	
01 1xxxxx	15	Reserved	[RFC-ietf-6lo-paging-dispatch-05]
10 xxxxxx	0	MESH - Mesh header	[RFC4944][RFC-ietf-6lo-paging-dispatch-05]
10 xxxxxx	1-14	Unassigned	
10 xxxxxx	15	Reserved	[RFC-ietf-6lo-paging-dispatch-05]
11 000xxx	0	FRAG1 -- Fragmentation Header (first)	[RFC4944][RFC-ietf-6lo-paging-dispatch-05]
11 000xxx	1-14	Unassigned	
11 000xxx	15	Reserved	[RFC-ietf-6lo-paging-dispatch-05]
11 001000 through 11 011111	0-14	Unassigned	
11 001000 through 11 011111	15	Reserved	[RFC-ietf-6lo-paging-dispatch-05]
11 100xxx	0	FRAGN -- Fragmentation Header (subsequent)	[RFC4944][RFC-ietf-6lo-paging-dispatch-05]
11 100xxx	1-14	Unassigned	
11 100xxx	15	Reserved	[RFC-ietf-6lo-paging-dispatch-05]
11 101000 through 11 101111	0-14	Unassigned	
11 101000 through 11 101111	15	Reserved	[RFC-ietf-6lo-paging-dispatch-05]
11 11xxxx	0-15	Page switch	[RFC-ietf-6lo-paging-dispatch-05]

http://www.iana.org/assignments/_6lowpan-parameters/_6lowpan-parameters.xhtml#lowpan_nhc

LOWPAN_IPHC Header



TF: Traffic Class, Flow Label

NH: Next Header

HLIM: Hop Limit

CID: Context Identifier Extension

SAC: Source Address Compression

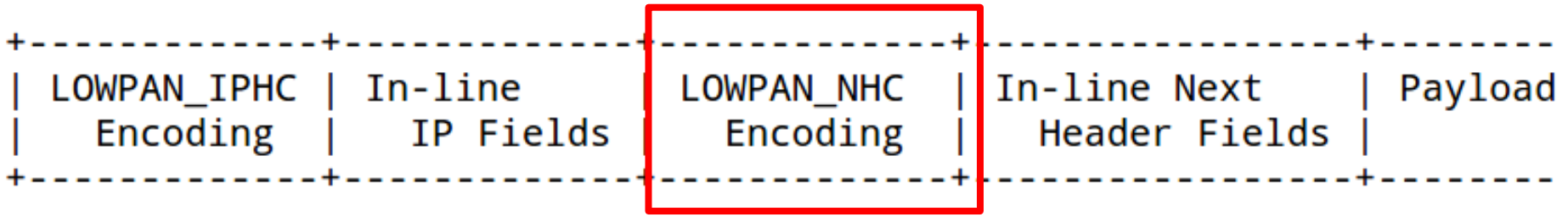
SAM: Source Address Mode

M: Multicast Compression

DAC: Destination Address Compression

DAM: Destination Address Mode

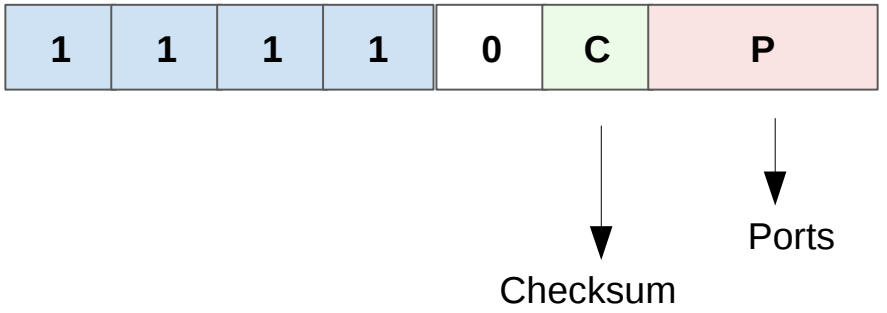
LOWPAN_NHC



Typical LOWPAN_IPHC/LOWPAN_NHC Header Configuration

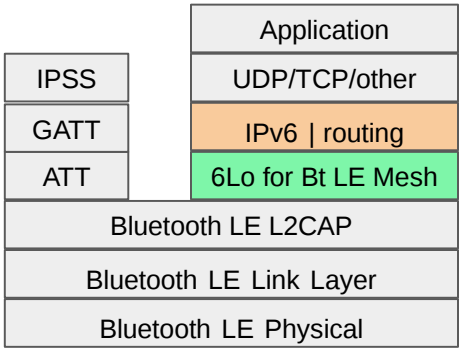
e.g.

LOWPAN_NHC: UDP Header Compression

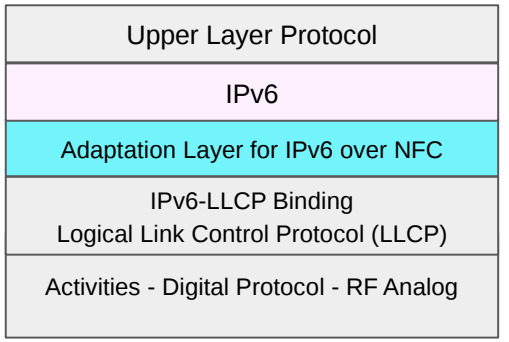


IPv6 over Networks of Resource-constrained Nodes (6lo) WG aims to extend 6LoWPAN to different technologies

- RFC 7428: Transmission of IPv6 Packets over ITU-T G.9959 Networks
- RFC 7668: IPv6 over BLUETOOTH(R) Low Energy
  - IPv6 over Bluetooth Low Energy Mesh Networks
    - draft-gomez-6lo-blemesh-02

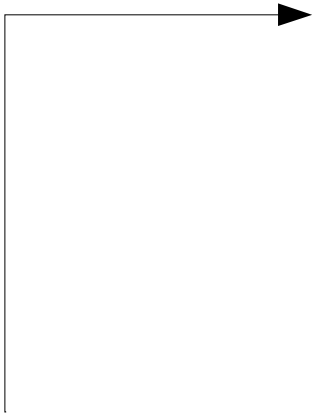


- Transmission of IPv6 Packets over Near Field Communication
  - draft-ietf-6lo-nfc-05



- An Update to 6LoWPAN ND
  - draft-thubert-6lo-rfc6775-update-01

Who else is playing
with 6LoWPAN?



IPv6 over the TSCH mode of IEEE 802.15.4e (6tisch)

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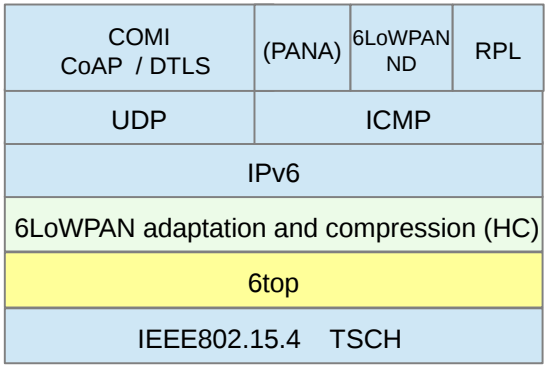
Industrial Networks

Time is divided in Slots in TSCH

Channel Hopping in TSCH transmit in different channels

6TiSCH Operation sublayer (6top) provides a set of commands for upper layers to set up specific schedules



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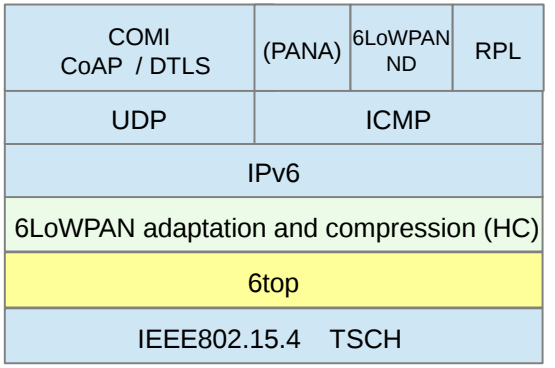

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IPv6 over Low Power Wide-Area Networks (lpwan)

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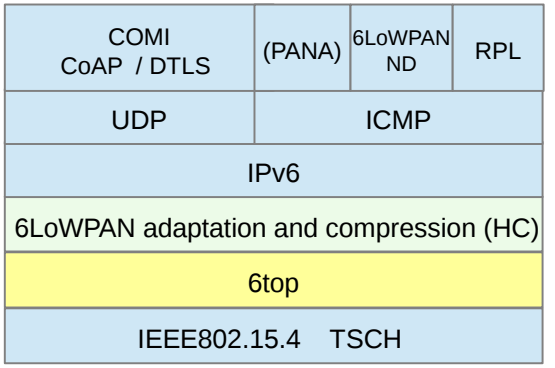
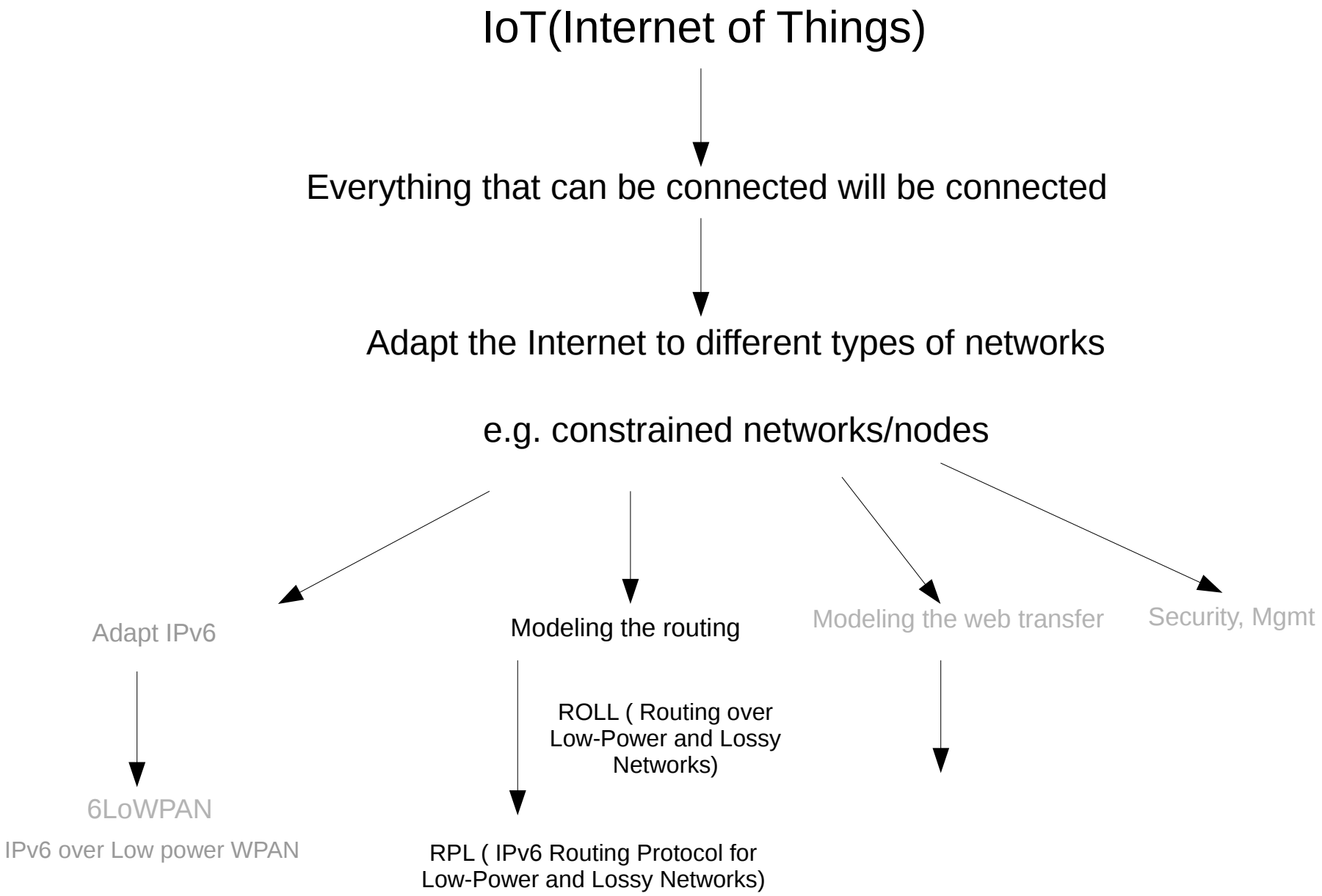


Who else is playing with 6LoWPAN?

IPv6 over Low Power Wide-Area Networks (lpwan)

The Working Group will focus on enabling IPv6 connectivity over the following selection of Low-Power Wide-Area technologies: SIGFOX, LoRa, WI-SUN and NB-IOT.

6LPWA Static Context Header Compression (SCHC) for IPV6 and UDP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ROLL (Routing over Low-Power and Lossy Networks)
6LoWPAN
IPv6 over Low power WPAN
RPL (IPv6 Routing Protocol for Low-Power and Lossy Networks)


ROLL WG
developed
RPL

ROLL WG

developed

RPL

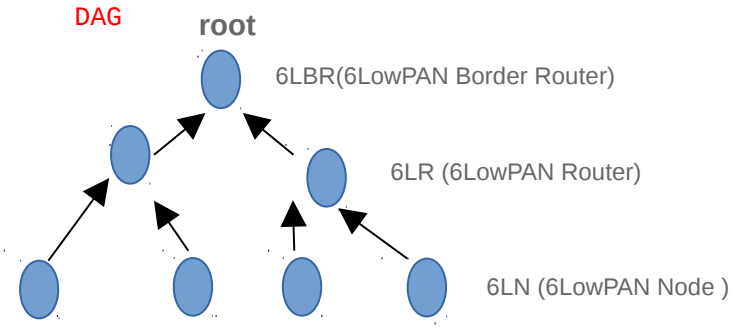
topology

Directed

Acyclic

Graph

DAG



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Destination-Oriented DAG

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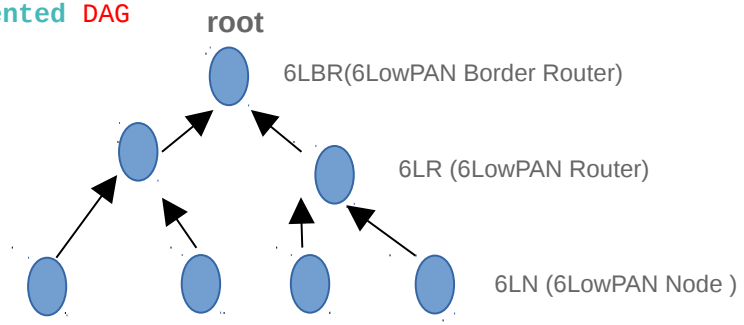
DODAG



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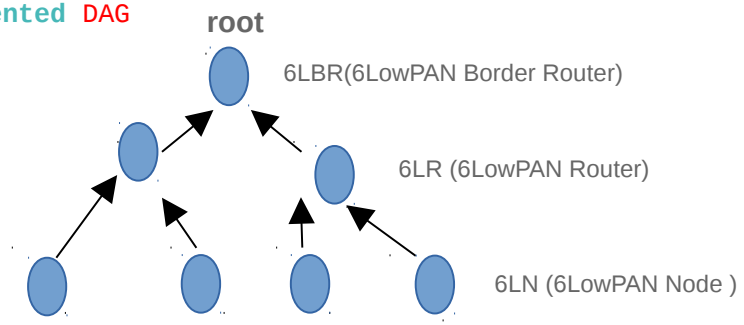

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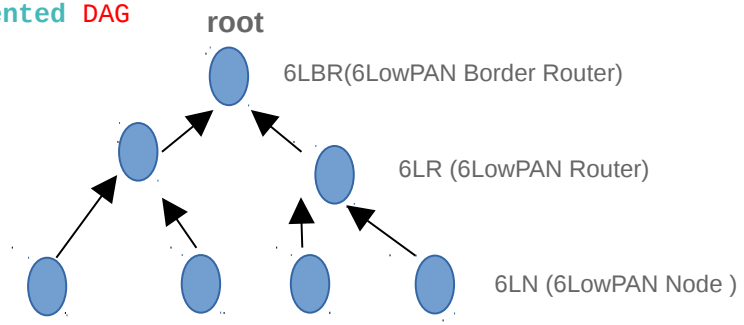

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Through Control Messages

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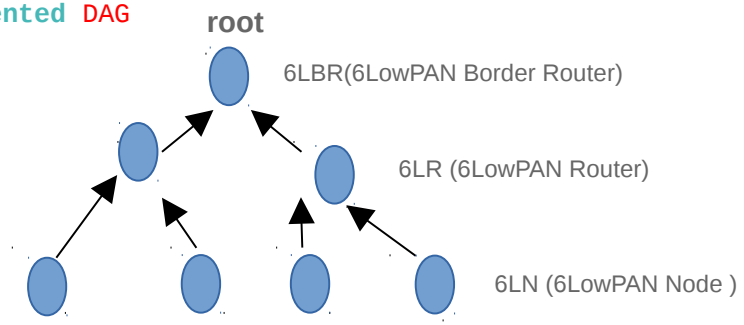

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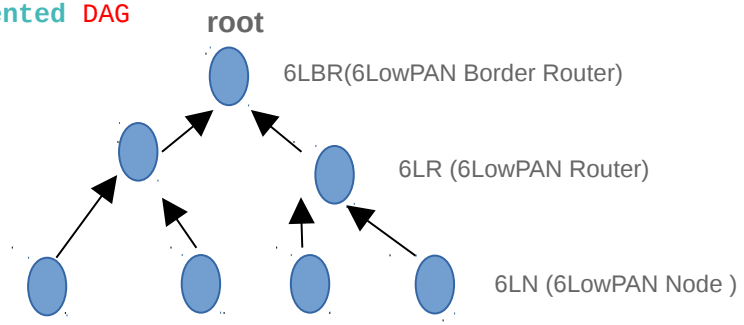

How we form the topology?

Through Control Messages

How I send the messages?

RPL Control message is a ICMPv6 message

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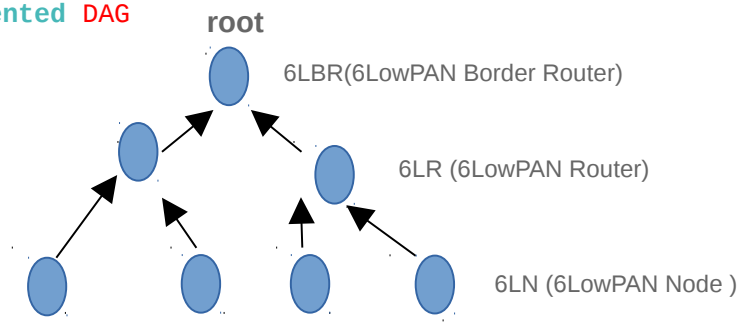

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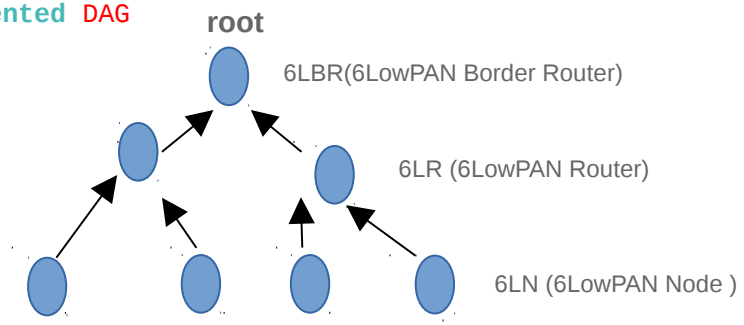

How we form the topology?

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To Request information to join the topology - DIS

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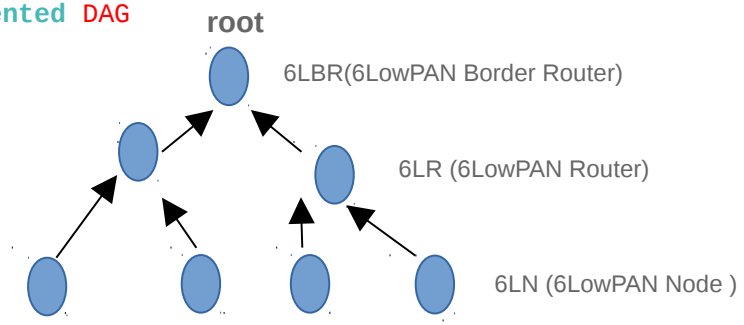

How we form the topology?

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RPL Control message is a ICMPv6 message

What types of messages we need?

To Request information to join the topology - DIS

To be able to send messages upwards - DIO

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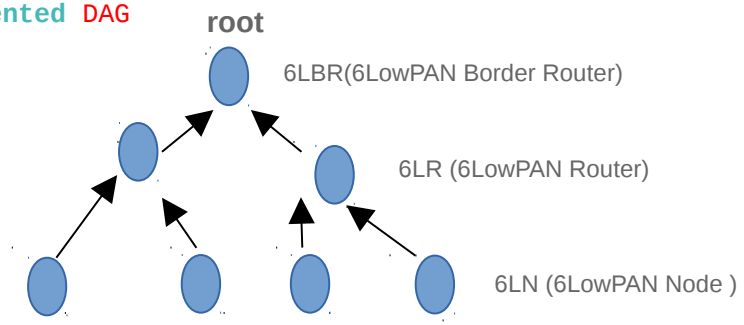

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To be able to send messages downwards DAO

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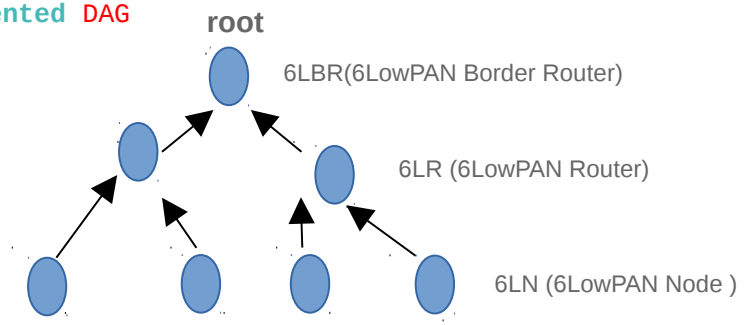

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Through Control Messages

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RPL Control message is a ICMPv6 message

What types of messages we need?

To Request information to join the topology - DIS

To be able to send messages upwards - DIO

To be able to send messages downwards DAO

To send the messages in a secure way

ROLL WG

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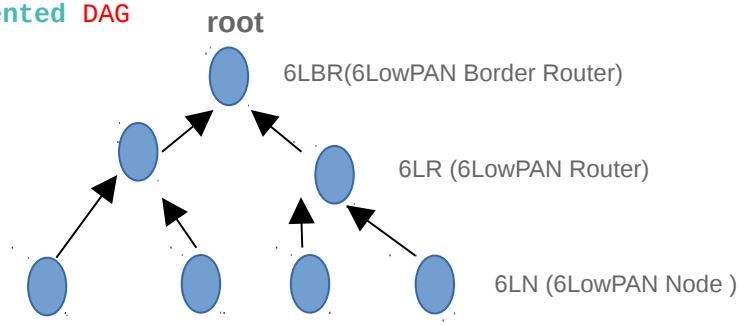

How we form the topology?

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How I send the messages?

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What types of messages we need?

To Request information to join the topology - DIS

How a node pick up a parent

To be able to send messages upwards - DIO

To be able to send messages downwards DAO

To send the messages in a secure way

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developed → RPL → topology

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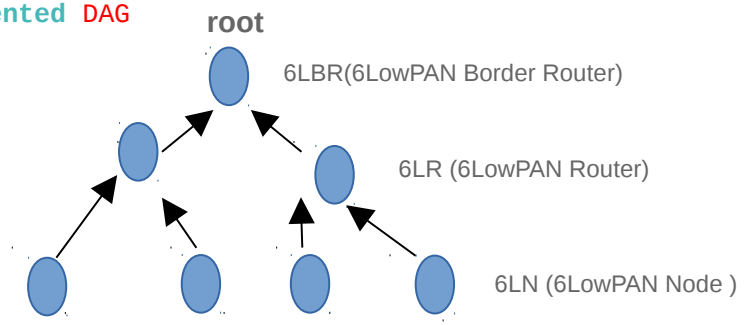


How we form the topology?

Through Control Messages

How I send the messages?

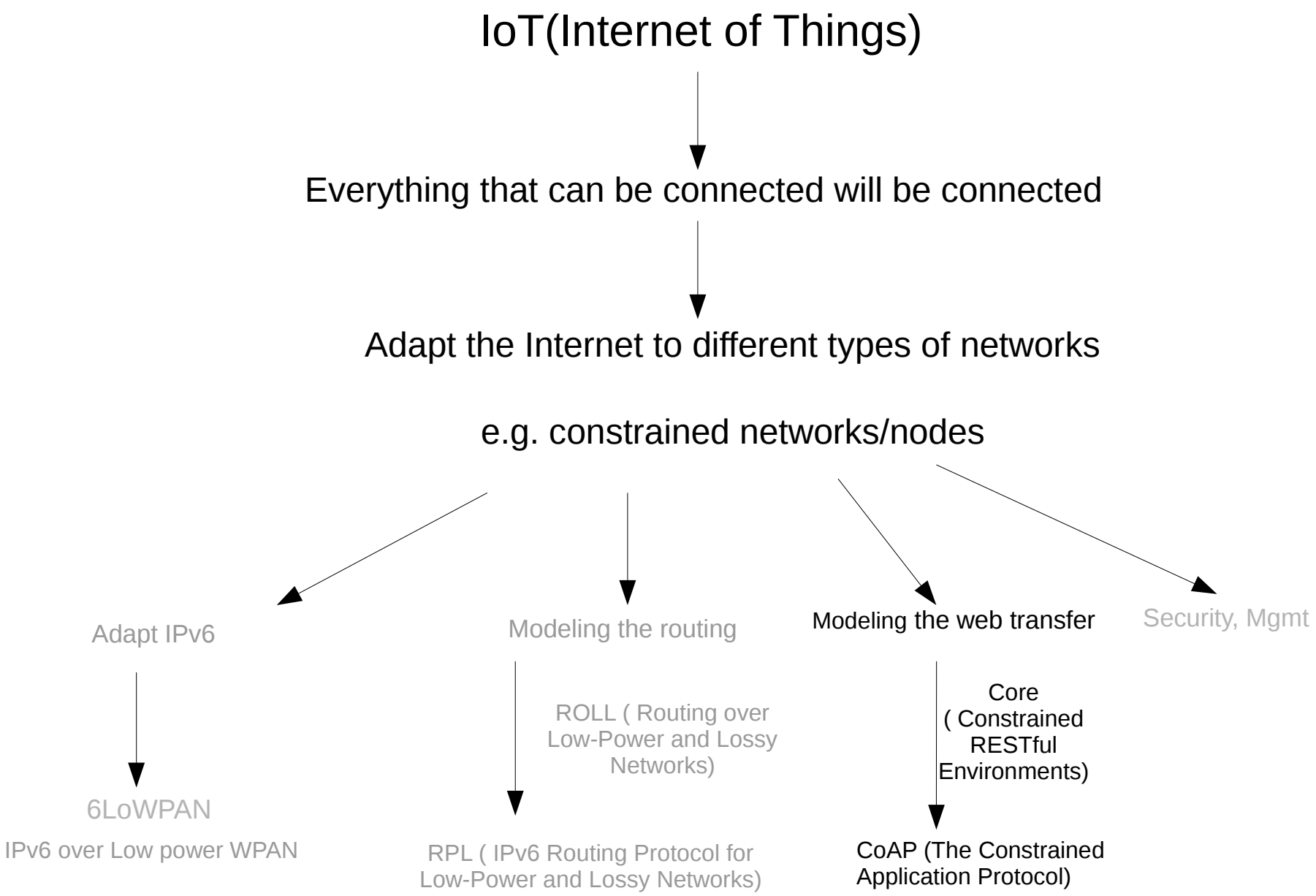
RPL Control message is a ICMPv6 message

What types of messages we need?

- To Request information to join the topology - DIS
  - How a node pick up a parent
    - **Objective Function (OF)**
      - Define how RPL nodes select and optimize routes within a RPL Instance.
      - Define how nodes translate one or more metrics into a rank.
      - Define how nodes select parents
- To be able to send messages upwards - DIO
- To be able to send messages downwards DAO
- To send the messages in a secure way

Some additional topics in ROLL

- 6LoWPAN Routing Header (6LoRH)
  - a method to compress RPL Option (RFC6553), information and Routing Header type 3 (RFC6554), an efficient IP-in-IP technique.
- Asymmetric AODV-P2P-RPL in Low-Power and Lossy Networks (LLNs)
  - reactive P2Proute discovery mechanism for hop-by-hop routing (storing mode) based on Ad Hoc On-demand Distance Vector Routing (AODV) based RPL protocol
- Root initiated routing state in RPL
  - enables to install a limited amount of centrally-computed routes in a RPL graph, enabling loose source routing down a non-storing mode DODAG
- MPL Forwarder Select (MPLFS)
  - reduce the density of forwarders such that the number of forwarded messages is reduced


IoT(Internet of Things)
Everything that can be connected will be connected
Adapt the Internet to different types of networks
e.g. constrained networks/nodes
Adapt IPv6
6LoWPAN
IPv6 over Low power WPAN
Modeling the routing
ROLL (Routing over Low-Power and Lossy Networks)
RPL (IPv6 Routing Protocol for Low-Power and Lossy Networks)
Modeling the web transfer
Core (Constrained RESTful Environments)
CoAP (The Constrained Application Protocol)
Security, Mgmt

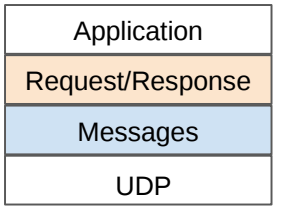
core WG → CoAP

developed

RESTful protocol:

-Client/server & Request/Response

- GET, POST, PUT, DELETE, PATCH, iPATCH, FETCH methods

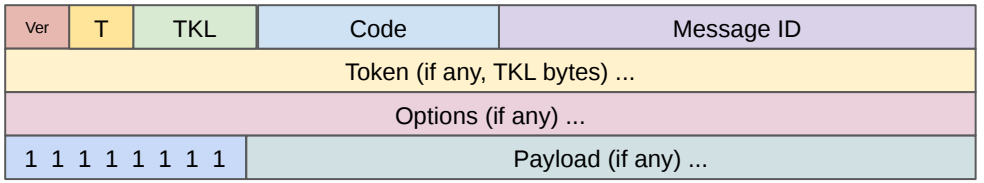


URI = host + port + path + query component

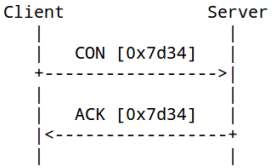
The well-know URI: `GET coap://[ipv6address]/.well-know/core`

Resource Discovery → Resource Directory (RD)

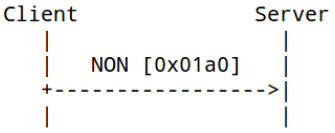
4 bytes Header



Messages Types: CON, NON, ACK, RESET



Confirmable (CON)



Non-Confirmable (NON)

Multicast: “All CoAP Nodes" - in IPv4: 224.0.1.187 - in IPv6: FF0X::FD

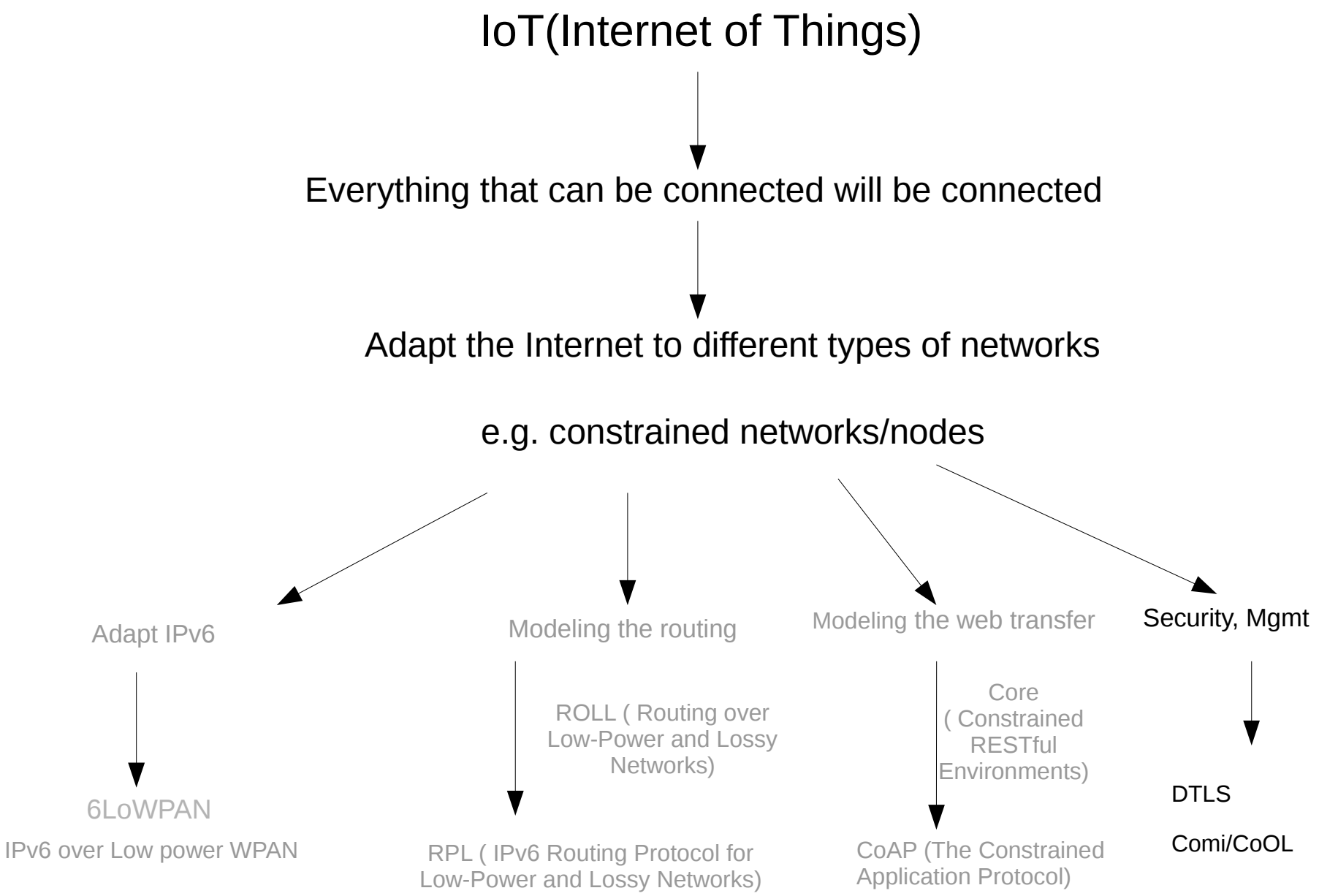
- Group Communications (RFC 7390)

Pub- Sub Architecture

Observe functionality

Some additional Features for CoAP

- CoAP (Constrained Application Protocol) over TCP, TLS, and WebSockets
- Dynamic Resource Linking for Constrained RESTful Environments
- Object Security of CoAP (OSCOAP)
- Representing CoRE Formats in JSON and CBOR
- YANG Schema Item iDentifier (SID)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Security, Mgmt
DTLS
Comi/CoOL

dice WG

RFC 7925: Transport Layer Security (TLS) /Datagram Transport Layer Security (DTLS) Profiles for the Internet of Things –

ace WG

Authentication and Authorization for Constrained Environments (ACE) – ace WG

lwig WG

Practical Considerations and Implementation Experiences in Securing Smart Object Networks

core WG

Object Security of CoAP (OSCOAP)

ROLL WG

A Security Threat Analysis for the Routing Protocol for Low-Power and Lossy Networks (RPLs)

Management Architecture/System

Management Protocols and Data Models

Software Distribution

Requirements on the Management of Networks with Constrained Devices (RFC7547)

Configuration Management

Traffic Management

Monitoring Functionality

Name	data size (e.g., RAM)	code size (e.g., Flash)
Class 0, C0	<< 10 KiB	<< 100 KiB
Class 1, C1	~ 10 KiB	~ 100 KiB
Class 2, C2	~ 50 KiB	~ 250 KiB

Classes of Constrained Devices - RFC7228

Self-Management

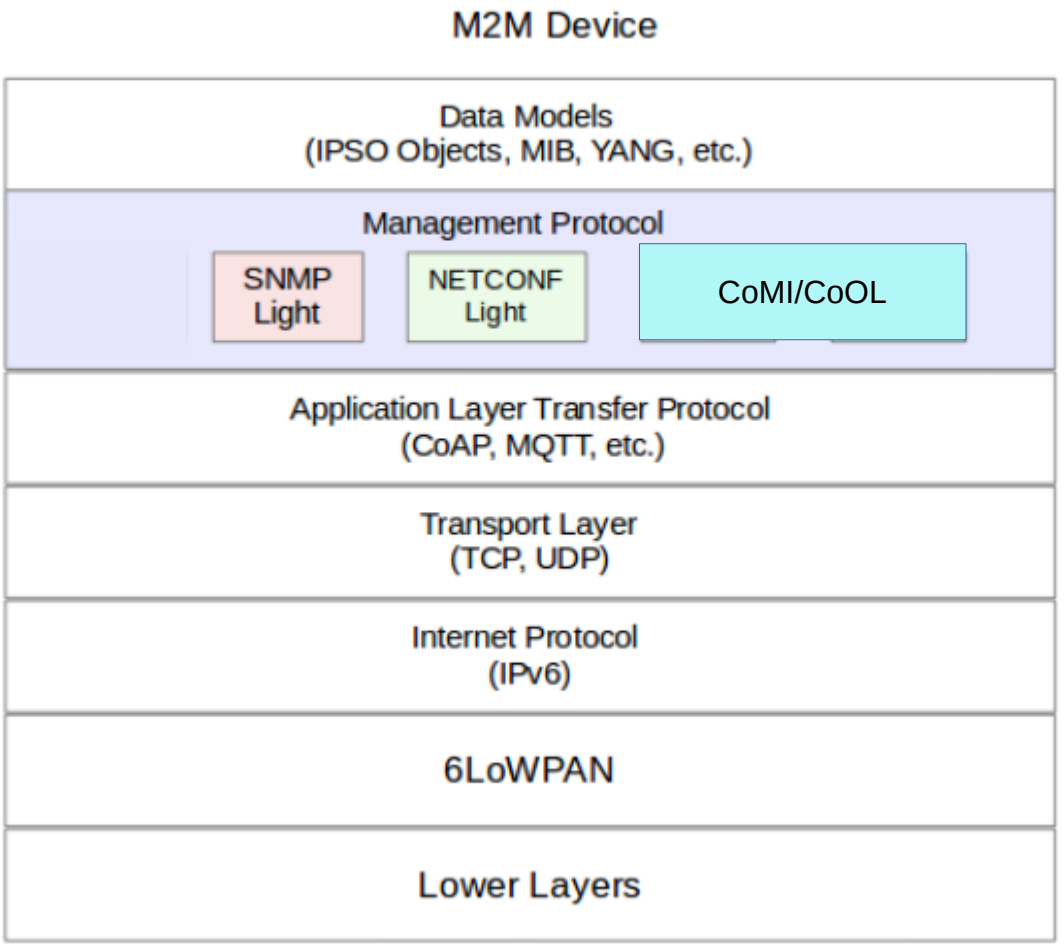
Implementation Requirements

Energy Management

Security and Access Control

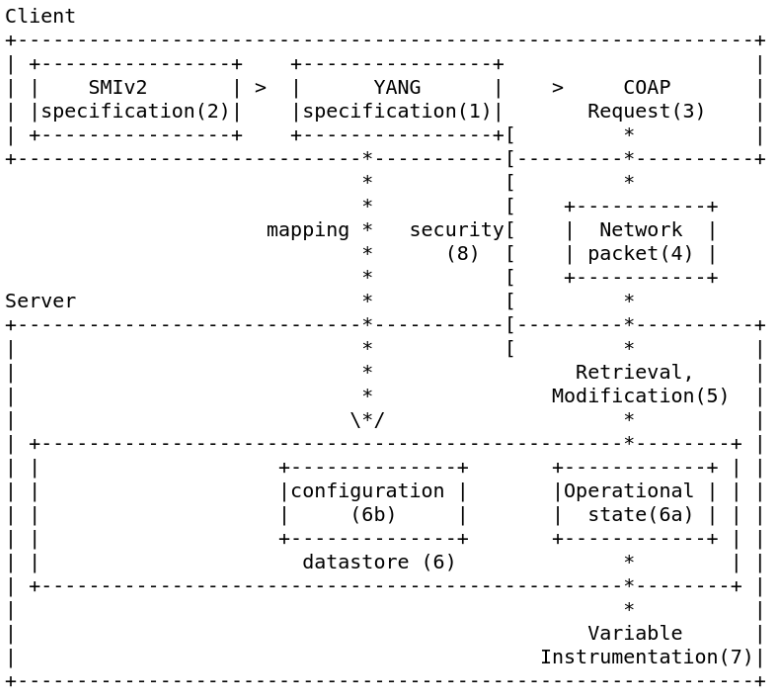
Transport Layer

IoT Device Management proposals



Constrained Management and Object Language (CoOL/CoMI)

- CoMI is a network management interface for constrained devices and networks, called CoAP management Interface (CoMI).
- The Constrained Application Protocol (CoAP) is used to access data resources specified in YANG, or SMIv2 converted to YANG.
- CoMI uses the YANG to CBOR mapping



Light-Weight Implementation Guidance (lwig)

Energy-Efficient Features of Internet of Things Protocols

Building Power-Efficient CoAP Devices for Cellular Networks

Minimal Internet Key Exchange Version 2 (IKEv2) Initiator Implementation

Practical Considerations and Implementation Experiences in Securing Smart Object Networks

T2TRG- THINGS TO THINGS RESEARCH GROUP

Some Topics:

The Constrained RESTful Application Language (CoRAL)

RESTful Design for Internet of Things Systems

Media Types for Hypertext Sensor Markup (HSML)

Guidance Design of Architecture and Data Model for Internet of Things Systems

Takeaways

6lo works to bring IPv6 into different types of Networks through 6LoWPAN protocol

ROLL works on rotuing aspects, it developed a main protocol RPL

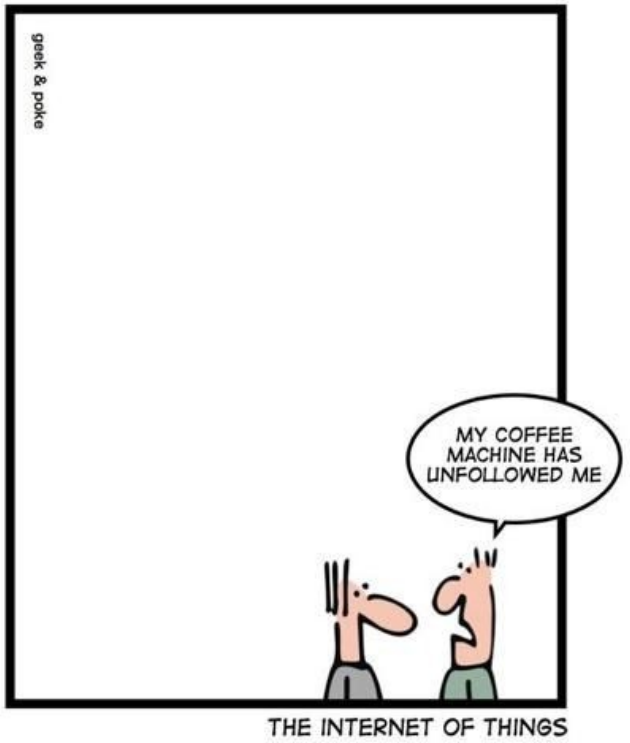
core works on web transfer aspects through CoAP

ace works on security aspects

lwig provides guidelines for implementers

T2TRG works on open items for IoT

Thank you very much!



References

6lo WG	https://datatracker.ietf.org/wg/6;o/documents/
ROLL WG	https://datatracker.ietf.org/wg/roll/documents/
Core WG	https://datatracker.ietf.org/wg/core/documents/
Lwig WG	https://datatracker.ietf.org/wg/lwig/documents/
ACE WG	https://datatracker.ietf.org/wg/ace/documents/
IoT Summary	https://www.w3.org/2015/04/munich/bormann.pdf
T2TRG	https://datatracker.ietf.org/rg/t2trg/documents/