

# IETF Participation

## Experiences and Contributions

**Awareness Program on Internet Protocols and Standards**  
**College of Engineering, Thiruvananthapuram**

**11<sup>th</sup> August 2018**

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**Centre for Development of Advanced Computing (C-DAC), Thiruvananthapuram**  
A Scientific Society of Ministry of Communications and Information Technology  
**Government of India**

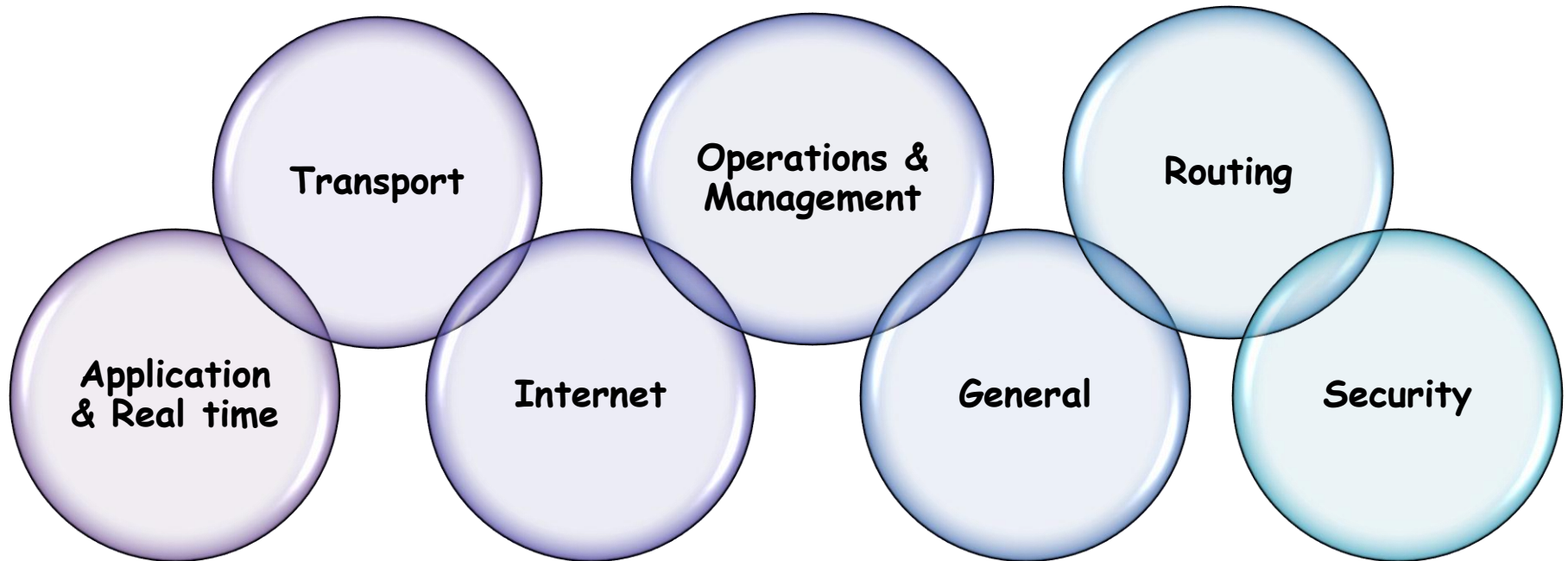
# Overview

- ❑ Introduction
- ❑ 6TiSCH WG
- ❑ IETF Activities - WIPSeN Project
  - Aim & Objectives
  - Participation in IETF Draft proposals
  - New IETF Draft proposals
  - Participation in IETF meetings
  - 6TiSCH Testbed Activities
  - National Workshops
- ❑ Contribute to IETF
- ❑ IETF Fellowships
- ❑ Conclusion

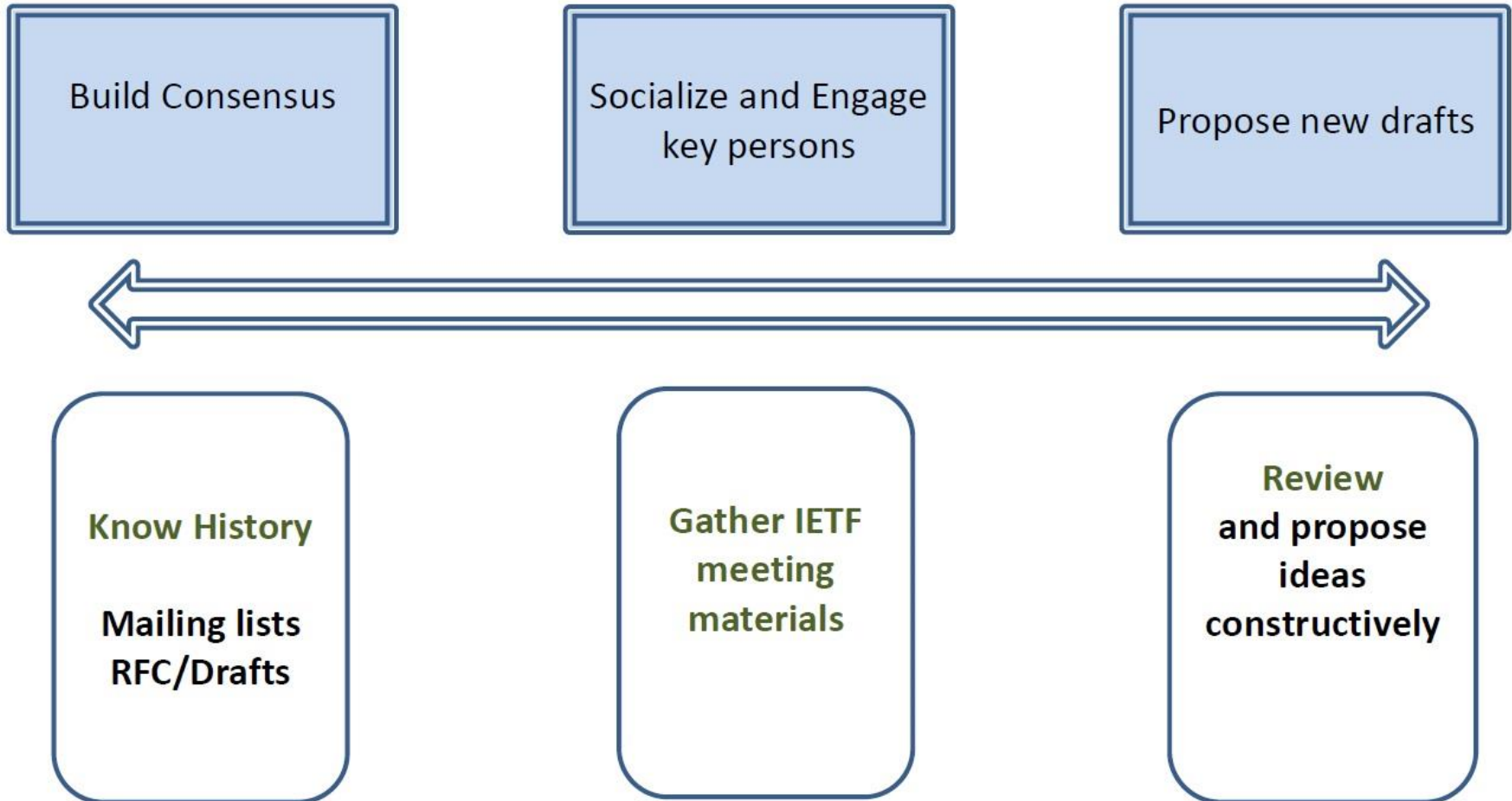
# Introduction

- ❑ The **Internet Engineering Task Force (IETF)** is a global community of network designers, operators, vendors, and researchers that develops Internet protocols
- ❑ **GOAL** : To make the Internet work better
- ❑ Technical work of the IETF is carried out in **Working Groups (WGs)**
  - WGs are the primary mechanism for the development of IETF specifications and guidelines, many of which are intended to be standards or recommendations
  - Work Groups(WGs) will be chartered with one or more deliverables
- ❑ Most of the work happens online over WG mailing lists
  - In-person interactions take place during IETF meetings
  - Virtual meetings can happen often

# IETF Working Areas



# IETF Culture and Proceedings

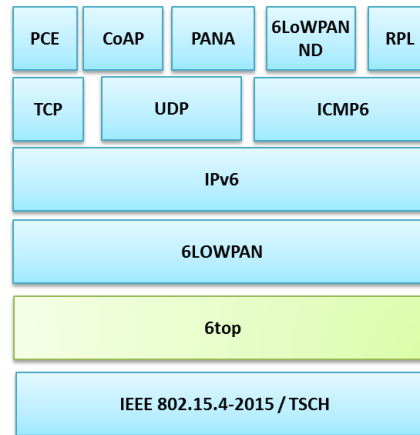


# IETF 6TiSCH WG

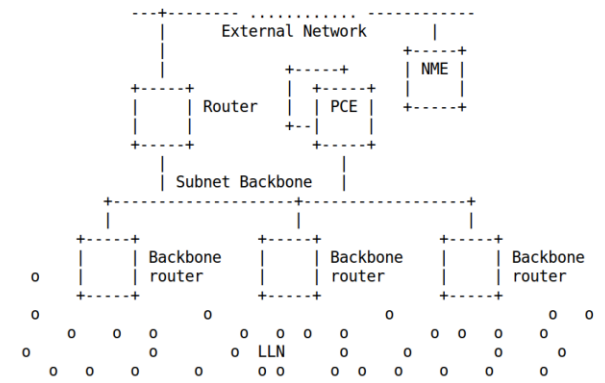
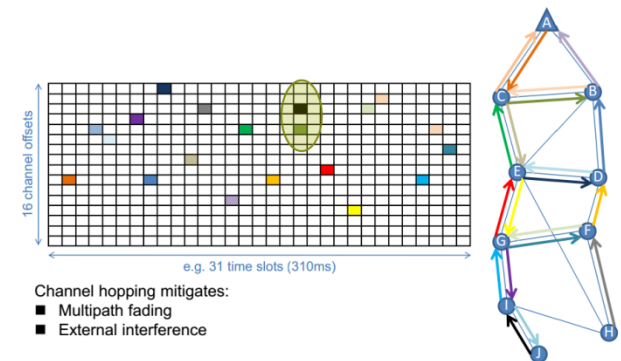
6TiSCH WG focuses on enabling IPv6 over the TSCH mode of the IEEE 802.15.4-2015 standard

## Current Charter Highlights

- Propose Minimalistic Operation to setup a IPv6 network over 6TiSCH network
- Distributed routing over a static schedule using RPL
- Dynamic allocation of cells between peer nodes
- Joining Securely
- Creating Deterministic Tracks
- 6TiSCH Architecture
- 6top Sublayer
- 6top Scheduling Function



6TiSCH protocol stack



6TiSCH Network

# WIPSeN Project

**W**ireless **I**nternet **P**rotocol enabled Time  
slotted and Channel hopping **S**ensor **N**etwork

# WIPSeN

## □ Aim

- Active participation in the IETF draft proposals
- Participation in the IETF discussion groups
- 6TiSCH testbed for evaluating the proposed architecture and IETF drafts and provide valuable feedback to IETF community
- Propose new IETF draft proposals
- Conduct National Workshops to create awareness

## □ Funding Agency

- Ministry of Electronics and Information Technology,  
Government of India



# IETF WG's of Interest

**6TiSCH**

**IPv6 over the TSCH mode of IEEE 802.15.4e**

**ROLL**

**Routing Over Low power and Lossy networks**

**DetNet**

**Deterministic Networking**

**6Lo**

**IPv6 over Networks of Resource-constrained Nodes**

# Active Participation in the IETF draft proposals

## □ WG mailing list discussions

Actively participated in the 6tisch, roll, detnet and 6lo WG mailing list discussions where we proposed valuable suggestions and provided feedback to the existing drafts.

- Transmit Power Control proposal in the 6top layer was well received. Invited to write proposal for IEEE 802.15.4

<http://www.ietf.org/mail-archive/web/6tisch/current/msg03969.html>

- Participated in more than 8 IETF draft proposals and received positive response from authors and working group members

## □ WebEx meetings

Actively participated in bi-weekly WebEx meetings

[https://bitbucket.org/6tisch/meetings/wiki/170623\\_webex](https://bitbucket.org/6tisch/meetings/wiki/170623_webex)

# Participation in IETF Meetings

## ❑ IETF 96

Team members attended the **IETF96** meeting held at **Berlin, Germany**



## ❑ IETF 97

- ❑ All the 3 drafts co-authored by us were presented during this meeting
- ❑ AODV-RPL draft has been adopted by ROLL WG

## ❑ IETF 98

A team member attended the **IETF98** meeting held at **Chicago, USA**



## ❑ IETF 99

- ❑ Version-4 of our packet expiration time draft was presented in 6lo WG
- ❑ Remotely presented the draft and OpenWSN work to 6TiSCH WG
- ❑ New version of AODV-RPL was presented

## ❑ IETF100

Our team member got Internet Society (ISOC) fellowship and attended the **IETF100** meeting held at **Singapore**

# New IETF Drafts

## 3 IETF drafts proposed

### ❑ Packet Delivery Deadline time in 6LoWPAN Routing Header

Working Group Name: IPv6 over Networks of Resource-constrained Nodes (6lo)

Area: Internet Area (int)

### ❑ Asymmetric AODV-P2P-RPL in Low-Power and Lossy Networks (LLNs)

Working Group Name: Routing Over Low power and Lossy networks (roll)

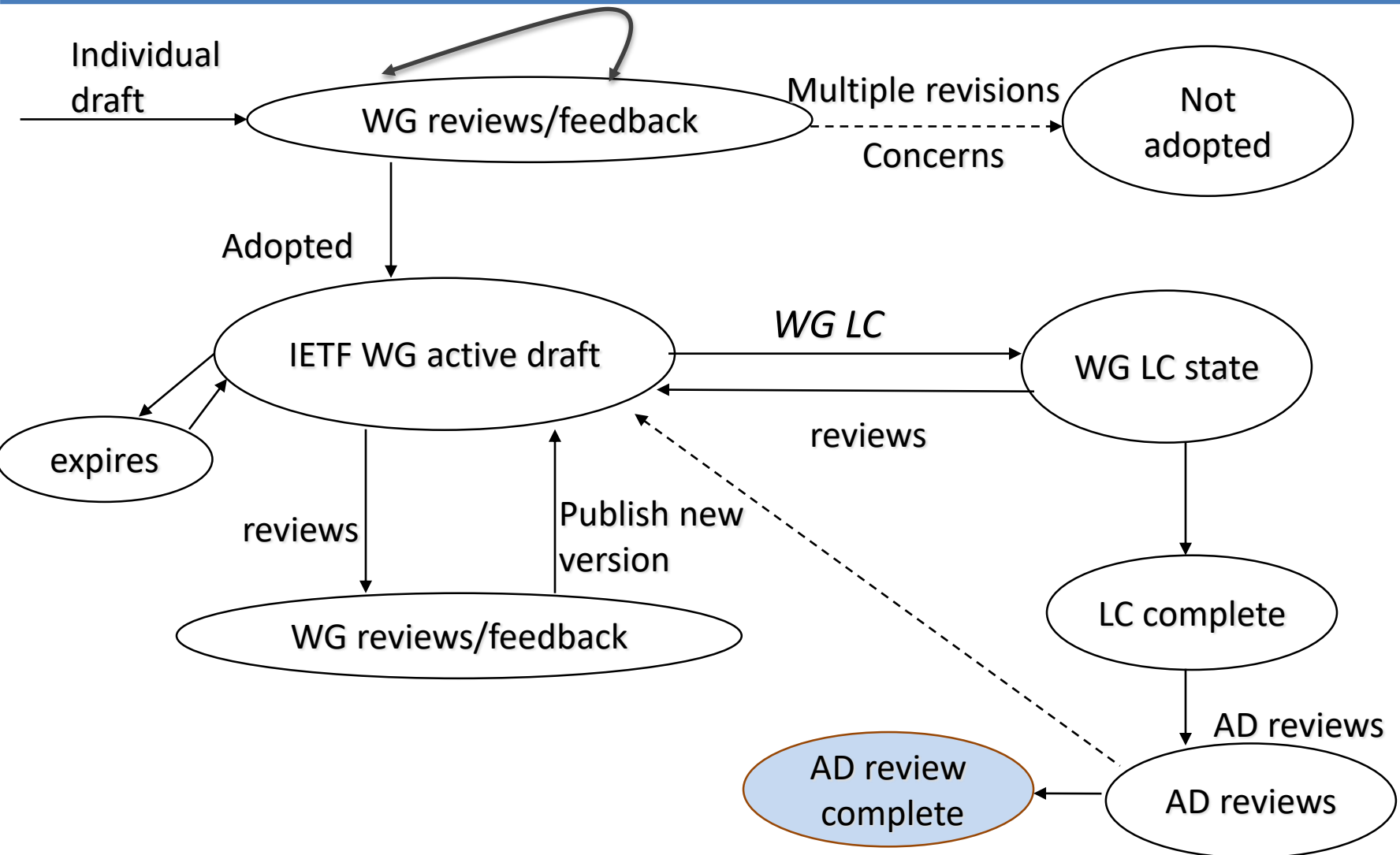
Area: Routing Area (rtg)

### ❑ Scheduling Function One(SF1) for hop-by-hop Scheduling in 6tisch Networks

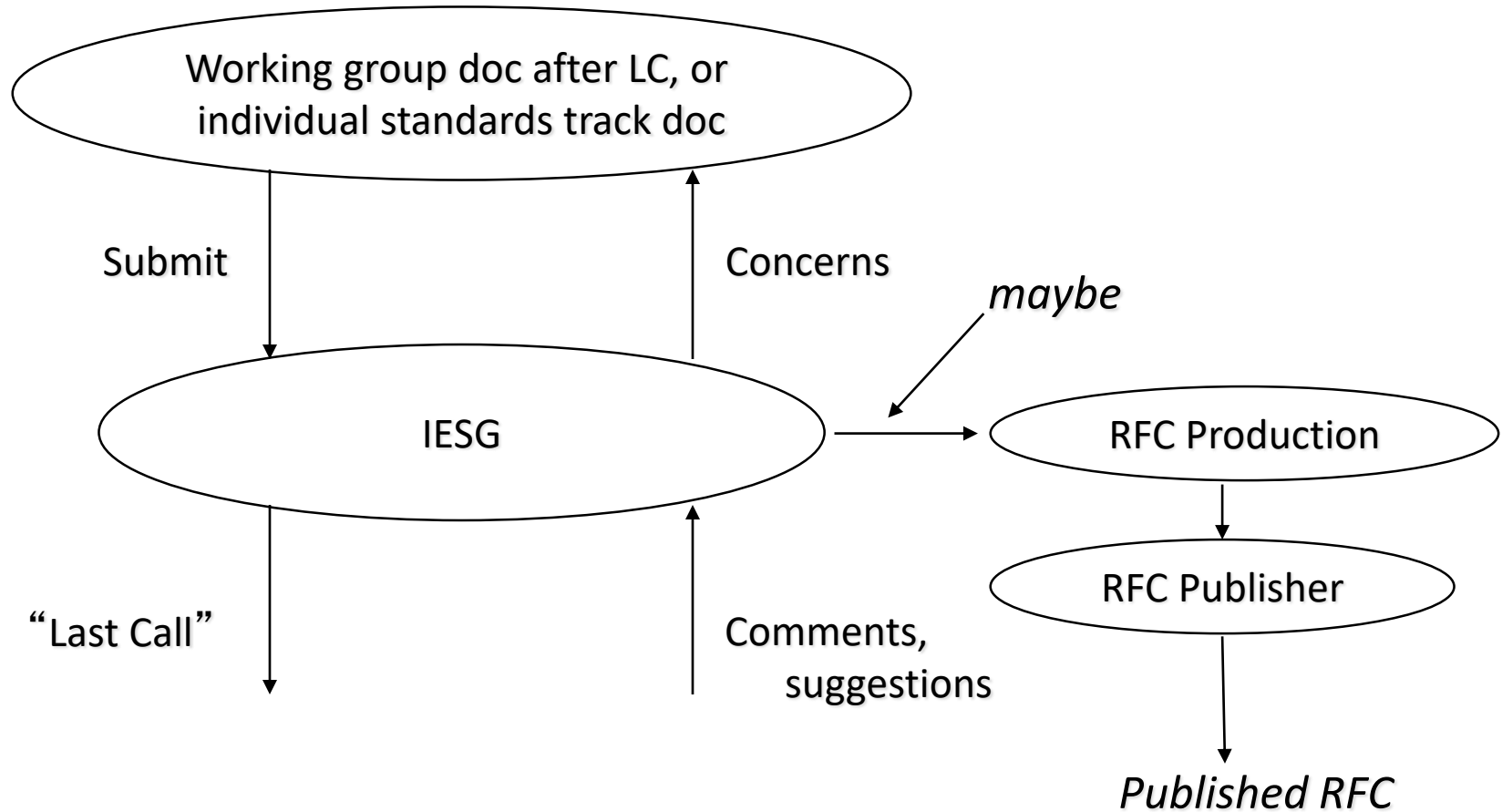
Working Group Name: IPv6 over the TSCH mode of IEEE 802.15.4e (6tisch)

Area: Internet Area (int)

# Life Cycle of a draft in WG



# Life Cycle of a draft after LC



# IETF draft 1 - Packet Delivery Deadline time in 6LoWPAN Routing Header

- Draft proposed in 6Lo Working Group
- Link : <https://datatracker.ietf.org/doc/draft-ietf-6lo-deadline-time/>
- Draft revisions were presented in IETF97, IETF98, IETF99 meetings
- Implemented the draft in OpenWSN which has been integrated with the OpenWSN main distribution and is available for free download

6lo  
Internet-Draft  
Intended status: Standards Track  
Expires: September 5, 2018

Lijo Thomas  
C-DAC  
P. Akshay  
Smarten Spaces  
Satish Anamalamudi  
Huaiyin Institute of Technology  
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Malati Hegde  
Indian Institute of Science  
C. Perkins  
Futurewei  
March 4, 2018

Packet Delivery Deadline time in 6LoWPAN Routing Header  
draft-ietf-6lo-deadline-time-01

## Abstract

This document specifies a new type for the 6LoWPAN routing header containing the delivery deadline time for data packets. The deadline time enables forwarding and scheduling decisions for time critical IoT M2M applications that need deterministic delay guarantees over constrained networks and operate within time-synchronized networks.

# IETF draft 2 - Asymmetric AODV-P2P-RPL in Low-Power and Lossy Networks (LLNs)

- Draft proposed in ROLL Working Group
- Link : <https://datatracker.ietf.org/doc/draft-ietf-roll-aodv-rpl/>
- Draft revisions presented in IETF 96,97,98,99 meetings
- Implemented the draft in Contiki OS

ROLL  
Internet-Draft  
Intended status: Standards Track  
Expires: September 6, 2018

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Huawei Technologies  
March 5, 2018

Asymmetric AODV-P2P-RPL in Low-Power and Lossy Networks (LLNs)  
draft-ietf-roll-aodv-rpl-03

## Abstract

Route discovery for symmetric and asymmetric Point-to-Point (P2P) traffic flows is a desirable feature in Low power and Lossy Networks (LLNs). For that purpose, this document specifies a reactive P2P route discovery mechanism for both hop-by-hop routing and source routing: Ad Hoc On-demand Distance Vector Routing (AODV) based RPL protocol. Paired Instances are used to construct directional paths, in case some of the links between source and target node are asymmetric.



# IETF draft 3 - Scheduling Function One (SF1) for hop-by-hop Scheduling in 6tisch Networks

- Draft proposed in 6TiSCH Working Group
- Link : <https://datatracker.ietf.org/doc/draft-satish-6tisch-6top-sf1/>
- Draft reviewed in IETF 96, 97 meetings

6tisch  
Internet-Draft  
Intended status: Standards Track  
Expires: April 30, 2018

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Huawei Technologies  
AR. Sangi  
Huaiyin Institute of Technology  
C. Perkins  
Futurewei  
S.V.R.Anand  
Indian Institute of Science  
October 27, 2017

Scheduling Function One (SF1): hop-by-hop Scheduling with RSVP-TE in  
6tisch Networks  
draft-satish-6tisch-6top-sf1-04

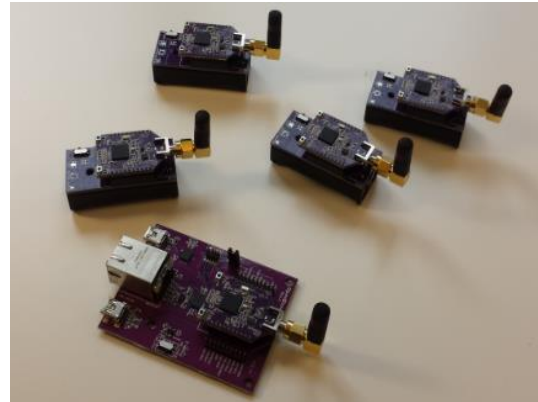
## Abstract

This document defines a 6top Scheduling Function called "Scheduling Function One" (SF1) to reserve, label and schedule the end-to-end resources hop-by-hop through the Resource ReserVation Protocol - Traffic Engineering (RSVP-TE). SF1 uses the 6P signaling messages with a global TrackID to add or delete the cells in L2-bundles of

# 6TiSCH Testbed Activities

## □ Hardware

- OpenMote
- WiSMote
- Telosb

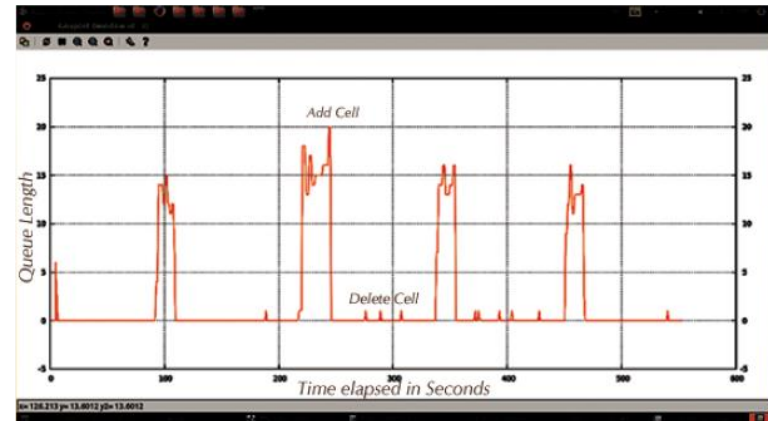


## □ Software

- ContikiOS
- OpenWSN

## □ Simulation Environment

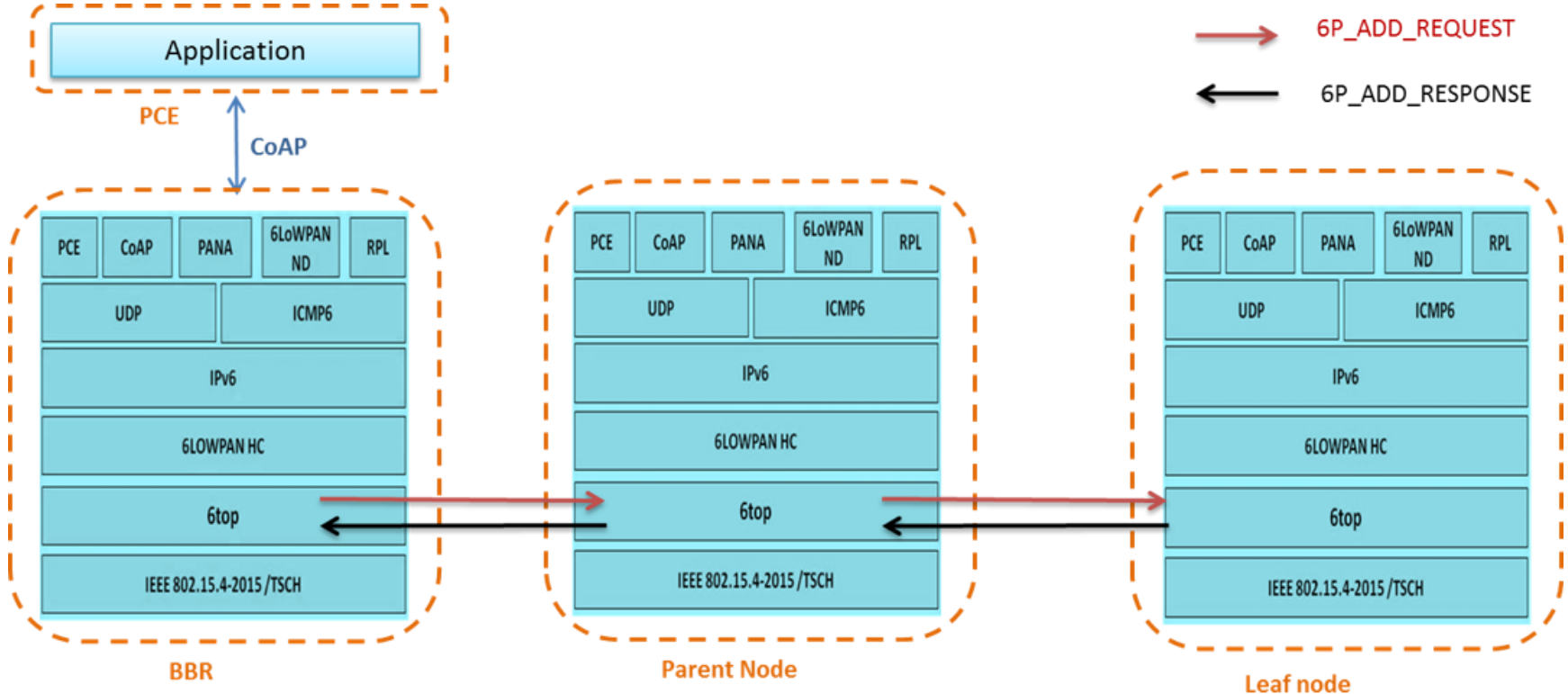
- Cooja
- Python Simulator



# 6TiSCH Testbed Activities

## 6top layer implementation on Contiki OS

- Designed and implemented the 6top layer on Contiki OS and validated the same using OpenMote Hardware and Cooja simulator
- Contributed the 6top layer code to Contiki OS



# 6TiSCH Testbed Activities

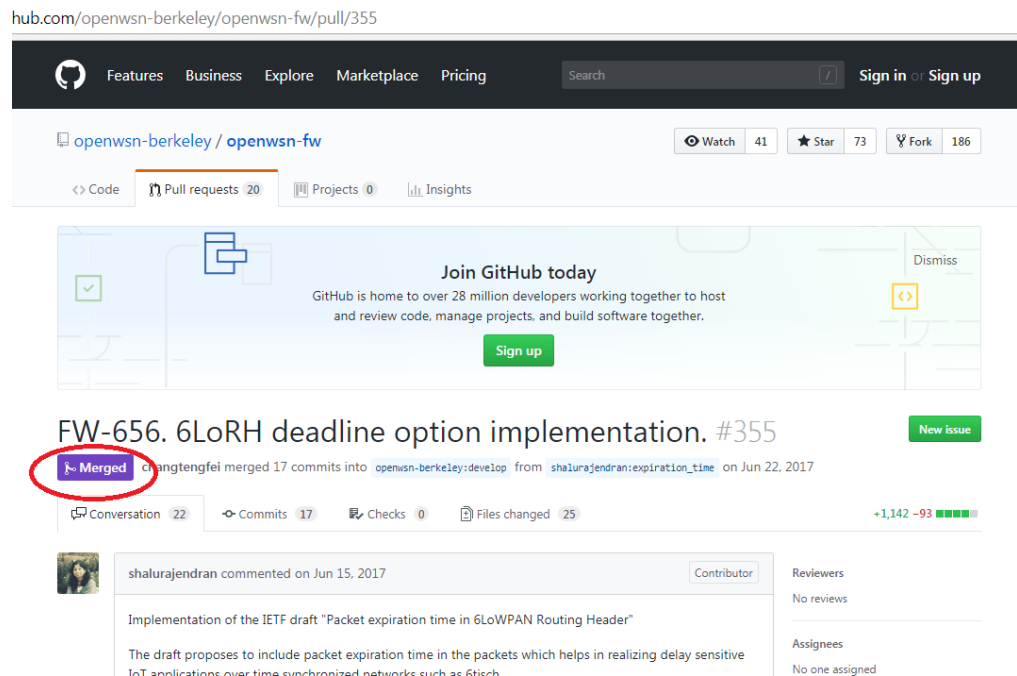
## 6Lo packet expiration draft implementation on OpenWSN

<https://github.com/openwsn-berkeley/openwsn-fw/pull/355>

<https://github.com/openwsn-berkeley/openwsn-sw/pull/150>

- Implemented our 6lo draft “draft-lijo-6lo-expiration-time-04” in OpenWSN
- Contributed to the OpenWSN open source distribution
- Implemented Earliest Deadline First scheduling algorithm

hub.com/openwsn-berkeley/openwsn-fw/pull/355



openwsn-berkeley / openwsn-fw

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FW-656. 6LoRH deadline option implementation. #355

Merged shangtengfei merged 17 commits into openwsn-berkeley:develop from shalurajendran:expiration\_time on Jun 22, 2017

Conversation 22 Commits 17 Checks 0 Files changed 25 +1,142 -93

shalurajendran commented on Jun 15, 2017

Implementation of the IETF draft "Packet expiration time in 6LoWPAN Routing Header"

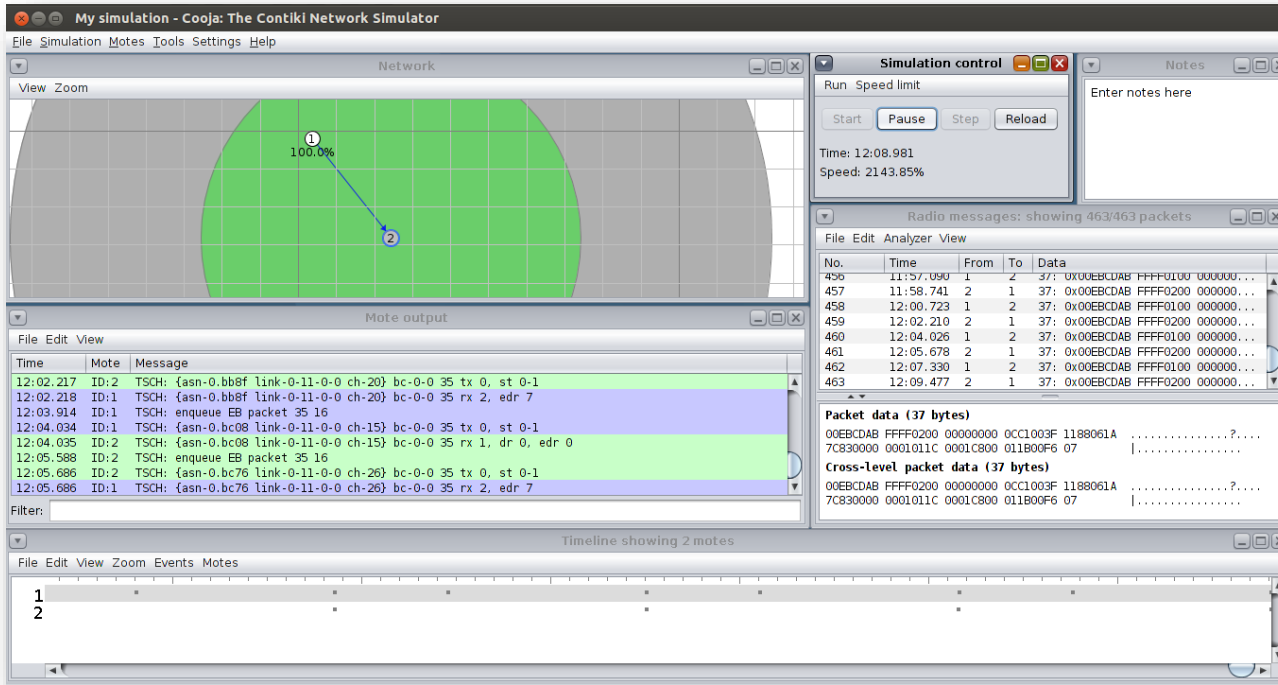
The draft proposes to include packet expiration time in the packets which helps in realizing delay sensitive IoT applications over time synchronized networks such as 6Tisch

# 6TiSCH Testbed Activities

- ❑ Implementation of AODV-RPL on Contiki OS
- ❑ For supporting delay sensitive IoT applications, a basic debt-based scheduling algorithm was designed and implemented on 6TiSCH simulator



**Testbed setup @ CDAC**



The screenshot shows the Cooja simulator interface with the following components:

- Network View:** A grid-based network diagram showing two nodes (1 and 2) connected by a link. Node 1 is at 100.0%.
- Simulation Control:** Run Speed limit window with Start, Pause, Step, and Reload buttons. Time: 12:08.981, Speed: 2143.85%.
- Radio messages:** A table showing 463/463 packets.
 

No.	Time	From	To	Data
457	11:58.741	2	1	37: 0x00EBCDAB FFFF0200 000000...
458	12:00.723	1	2	37: 0x00EBCDAB FFFF0100 000000...
459	12:02.210	2	1	37: 0x00EBCDAB FFFF0200 000000...
460	12:04.026	1	2	37: 0x00EBCDAB FFFF0100 000000...
461	12:05.678	2	1	37: 0x00EBCDAB FFFF0200 000000...
462	12:07.330	1	2	37: 0x00EBCDAB FFFF0100 000000...
463	12:09.477	2	1	37: 0x00EBCDAB FFFF0200 000000...
- Mote output:** Log messages showing network events and packet transmissions.
 

```

12:02.217 ID:2 TSCH: {asn-0.bb8f link-0-11-0-0 ch-20} bc-0-0 35 tx 0, st 0-1
12:02.218 ID:1 TSCH: {asn-0.bb8f link-0-11-0-0 ch-20} bc-0-0 35 rx 2, edr 7
12:03.914 ID:1 TSCH: enqueue EB packet 35 16
12:04.034 ID:1 TSCH: {asn-0.bc08 link-0-11-0-0 ch-15} bc-0-0 35 tx 0, st 0-1
12:04.035 ID:2 TSCH: {asn-0.bc08 link-0-11-0-0 ch-15} bc-0-0 35 rx 1, dr 0, edr 0
12:05.588 ID:2 TSCH: enqueue EB packet 35 16
12:05.686 ID:2 TSCH: {asn-0.bc76 link-0-11-0-0 ch-26} bc-0-0 35 tx 0, st 0-1
12:05.686 ID:1 TSCH: {asn-0.bc76 link-0-11-0-0 ch-26} bc-0-0 35 rx 2, edr 7
      
```
- Timeline:** A timeline showing two notes (1 and 2) corresponding to the simulation events.

**6tisch network simulation on Cooja simulator (Contiki OS)**

# Workshops

- ❑ First National workshop on “**IETF Participation and Emerging Industrial Networking Technologies**” was held at IISc, Bangalore on 21<sup>st</sup> April, 2016.



- ❑ Second National Workshop on “**Realising Anything as a Service in IoT : Technologies and Standards**”, was held at C-DAC, Thiruvananthapuram on 3<sup>rd</sup> March, 2017.



# Publications & Awards

## ❑ 6TiSCH Operation Sublayer (6top) implementation on Contiki OS

- Published a paper in COMSNETS 2017
- Available at **IEEE Xplore**

<http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=7945424>

## ❑ Received 3 IREF Fellowships funded by MeitY to attend IETF 96, 98 meetings at Germany & USA

<https://iiref.in/result>

## ❑ Received 1 ISOC Fellowship funded by Internet Society to attend IETF 100 meeting at Singapore

<https://www.internetsociety.org/leadership/fellowship-to-ietf/fellows/100/>



Indian Internet Research & Engineering Forum

Home Fellowship Call for Participation Results

### IREF Fellowship Result for IETF 98

Thank you for applying for IETF 98 fellowship.

We are pleased to inform that the following applicants have been selected for the IETF 98 fellowship.

1. Shri. Lijo Thomas, Senior Engineer, CDAC Thiruvananthapuram.
2. Smt. Smitha Vinod, Associate Professor, Christ University .

### IREF Fellowship Result for IETF 97

Thank you for applying for IETF 97 fellowship.

We are pleased to inform that the following applicant has been selected for the IETF 97 fellowship.

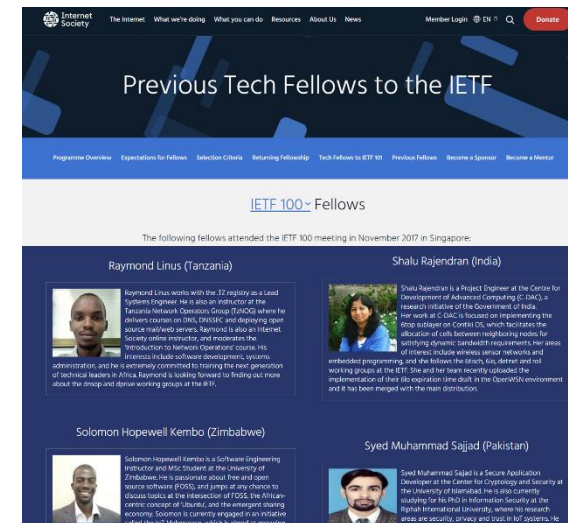
1. Shri. Shibendu Debbarma, Assistant Professor, Tripura University.

### IREF Fellowship Result for IETF 96

Thank you for applying for IETF 96 fellowship.

We are pleased to inform that the following applicants have been selected for the IETF 96 fellowship.

1. Shri. S V R Anand, IISc Bangalore.
2. Shri. Lijo Thomas, Senior Engineer, CDAC Thiruvananthapuram.



The screenshot shows the 'Previous Tech Fellows to the IETF' page on the Internet Society website. The page title is 'Previous Tech Fellows to the IETF'. Below the title, there is a section for 'IETF 100 - Fellows' with the text 'The following fellows attended the IETF 100 meeting in November 2017 in Singapore.' The page lists four fellows:

- Raymond Linus (Tanzania):** Raymond Linus works with the ZJ registry as a Lead Systems Engineer. He is also an instructor at the Tanzania Network Operations Group (TANOG) where he delivers courses on DNS, DHCP and deploying open source network services. Raymond is also an Internet Society online instructor, and provides the 'Introduction to Network Operations' course. His interests include software developers, systems administration, and he is extremely committed to training the next generation of technical leaders in Africa. Raymond is looking forward to finding out more about the in-person and virtual working groups at the IETF.
- Shalu Rajendran (India):** Shalu Rajendran is a Project Engineer at the Centre for Development of Advanced Computing (CDAC), a research institute of the Government of India. Her work at CDAC is focused on implementing the 6top sublayer on Contiki OS, which involves the allocation of cells between neighboring nodes for sending control packets. Her research interests include wireless sensor networks and embedded programming, and she follows the Linux, IoT, Debian and net working groups at the IETF. She and her team recently uploaded the implementation of their 6top explorer (see doc) in the OpenWRT environment and it has been merged with the main distribution.
- Solomon Hopewell Kembo (Zimbabwe):** Solomon Hopewell Kembo is a Software Engineering instructor and IoT Specialist at the University of Zimbabwe. He is passionate about free and open source software (FOSS) and aims at bringing it to rural areas at the intersection of FOSS, the African continent, concepts of Ubuntu, and the emerging digital economy. Solomon is currently engaged in an initiative called the IoT Makerspace, which is aimed at organizing...
- Syed Muhammad Sajjad (Pakistan):** Syed Muhammad Sajjad is a Security Application Developer at the Center for Cryptology and Security at the University of Islamabad. He is also currently working for his PhD in Information Security at the Faisal International University, where his research areas are security, privacy and trust in IoT systems. He...

# Contribute to IETF ?

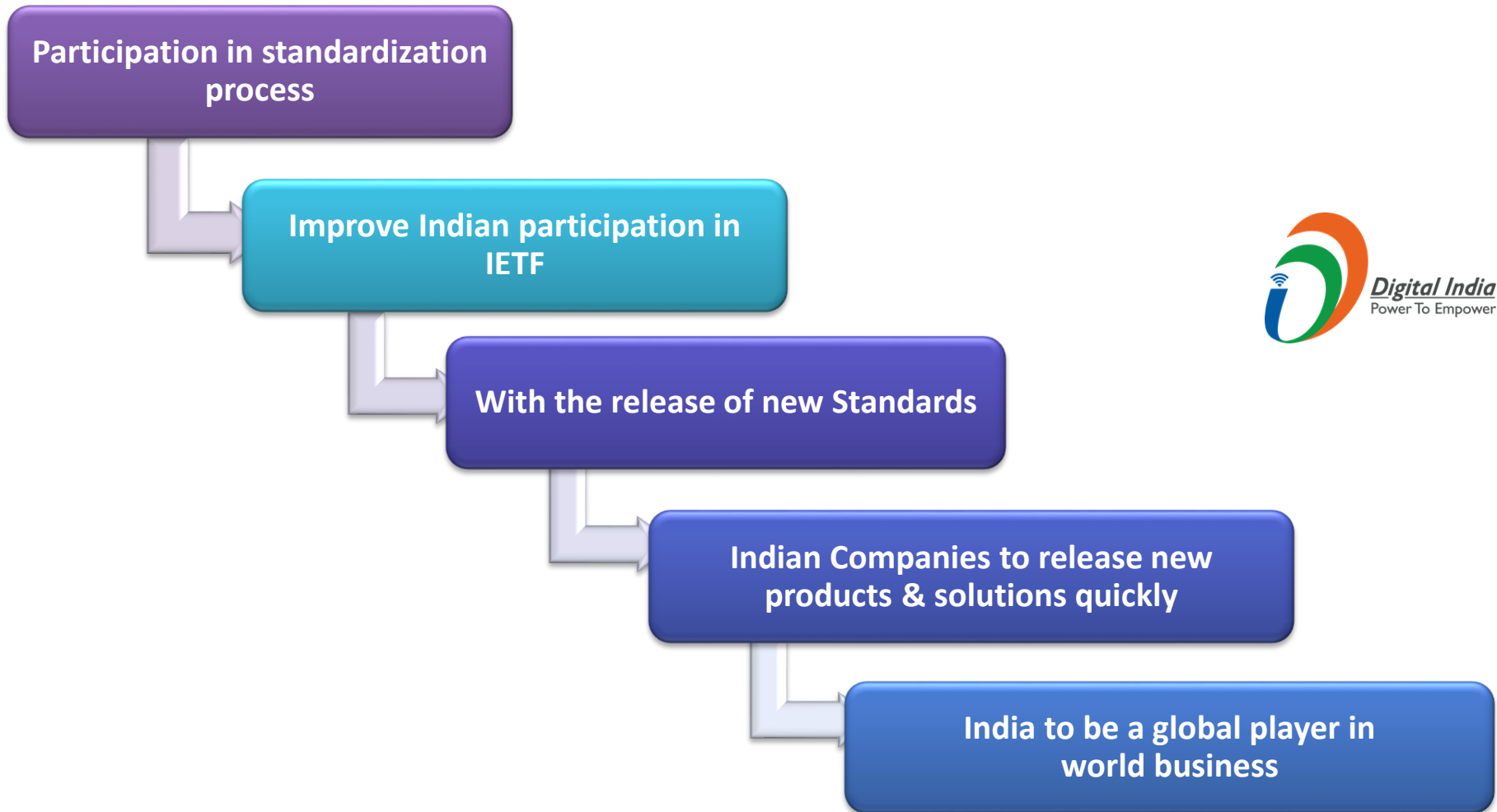




# IETF Fellowships



# Conclusion



# Thank You

Lijo Thomas  
Principal Engineer  
[lijo@cdac.in](mailto:lijo@cdac.in)

