IETF 103 (**バンコク**) **報告会**
5G**関連動向**(DMM, DetNet**など**)

2018/12/14

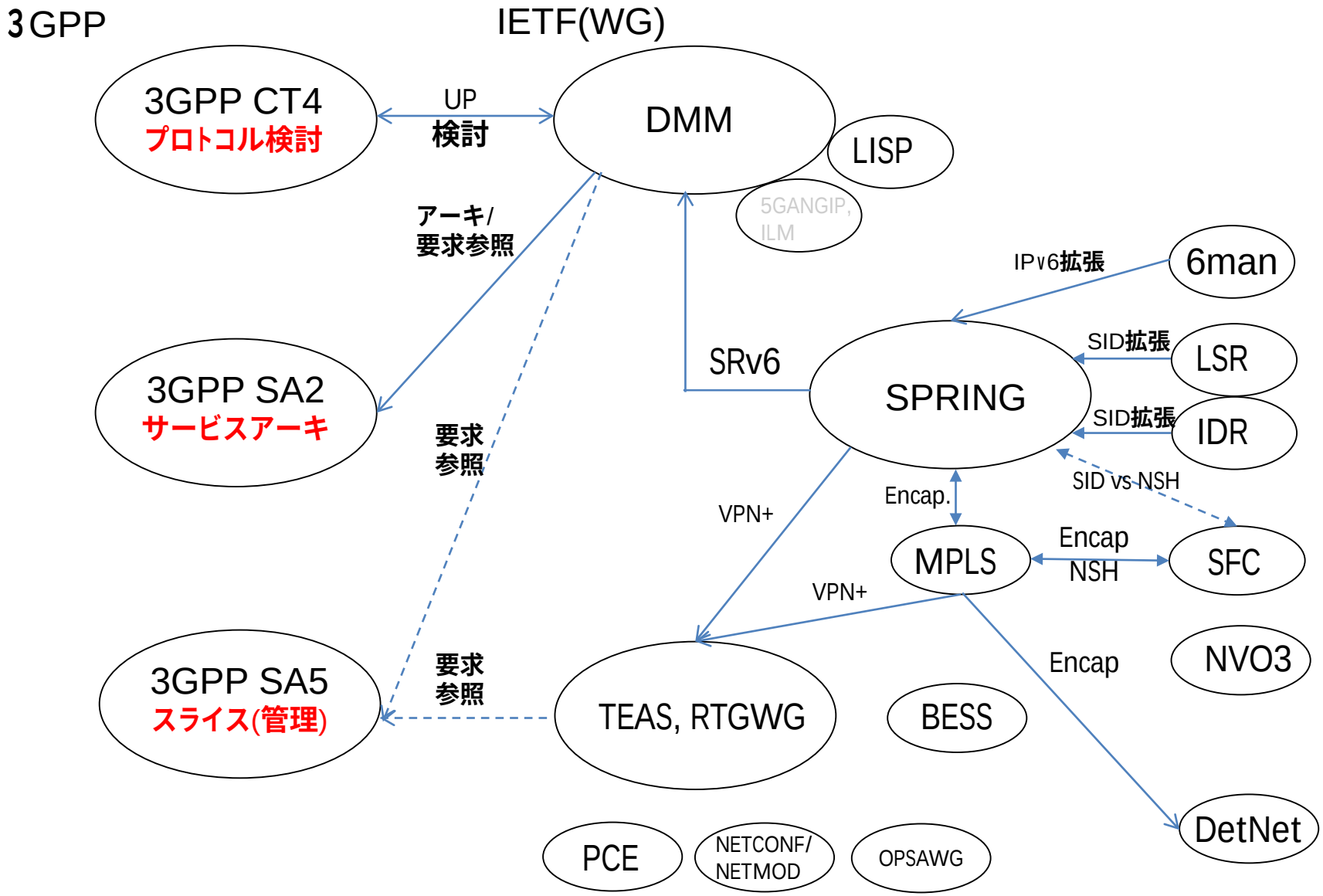
栃尾　祐治(富士通研究所)

本日の報告内容

- これまで、連続で報告頂いた 5G時代に向けた(関わる)IPv6動向またはRTG Area 動向について紹介

- 報告内容
  - DMM WG
    - Mobile SRv6などの進展
  - DetNet WG
    - 日曜日に行われた IEEE/IETF 合同Workshopも含む
  - TEAS WG
    - VPN+ またはスライス動向

3GPPからみたIETFとの関わり(個人見解)



※線がないところは、全般またはなんとなく関与(特にCPに)という意味で

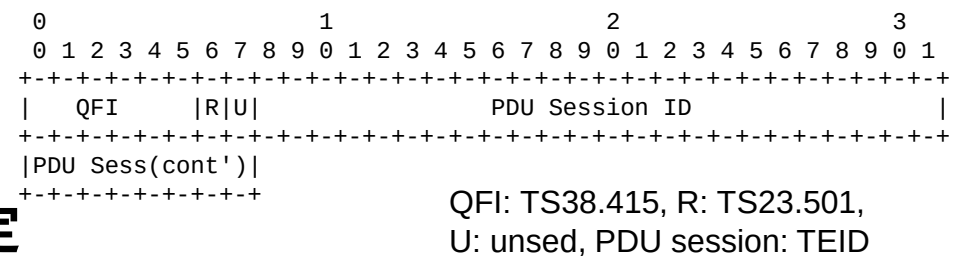
DMM WG

DMM WG(概要など)

- **Distributed Mobility Management WG**
  - **そもそもはIPv6をベースとしたモビリティ管理のWG**
  - **ご存知の通り3GPP 5G (Rls16以降)に向けたIPv6網のありかたを考えるWGで、3GPP CT4 (プロトコル検討)と密接に関連あるWG**
- **今回の会合で紹介された主なドラフトなど(今回紹介するもの)**
  - draft-ietf-dmm-srv6-mobile-uplane
  - draft-fattore-dmm-n6-cpdp-trafficsteering
  - draft-hmm-dmm-5g-uplane-analysis
  - draft-clt-dmm-tn-aware-mobility
  - draft-camarilloelmalky-springdmm-srv6-mob-usecases
  - *Time Sensitive Networking for 5G*
  - **その他は、以下参照**
    - https://datatracker.ietf.org/meeting/103/materials/agenda-103-dmm/

DMM WG (各ドラフトの主な進捗)

- draft-ietf-dmm-srv6-mobile-uplane-03
  - 6 章 (SRv6 SID Mobility Functions) に “Args.Mob.Session” for SID 定義
    - QFI and/or PDU session単位での柔軟な SRv6 提供に寄与するもの
  - End.MAP (6.1 à 6.2)修正
  - 今後は様々な UPF への対応予定



QFI: TS38.415, R: TS23.501,
U: unsed, PDU session: TEID

- draft-hmm-dmm-5g-uplane-analysis
  - ドラフト詳細は前回報告会で紹介。GTP-Uを中心にIETFにて3GPP 5G のUPの特性を検討し、課題を抽出するもの
  - 今回のupdateではGTP-Uのトンネル ID特性(TEID)やQFI (i.e. QoS mapping) 動作を中心に更新
    - 個人的にはArch-req-6, 7が大きな更新かと

- draft-camarilloelmalky-springdmm-srv6-mob-usecase
  - 今回はじめて、Mobile SRv6向けユースケースがドラフトとして紹介
  - ユースケース例: Radio-core Handoff, E2E network slicing, GiLAN Service Programming

DMM WG (draft-hmm-dmm-5g-uplane-analysis)

- @IETF103 (00 à 01)

Major Updates

Object	Ver.	Update Details
[GTP-U-1] Behavior as P2P tunneling protocol	01	• Referred implementation to allow the same TEID be used as the destination endpoint from multiple sources.
[GTP-U-6] Supporting IPv6 flow label for LB	01	• Mentioned no definition about load balancing with IPv6 flow label in TS29. 281.
[GTP-U-10] The order of extension header	01	• Referred the note, described in TS29. 281, to recommend putting QFI as the first header.
[Eval-Aspect-7] Specs of slice in 3GPP	01	• Added TS28. 531~533 as references about network slicing specifications and definitions.
[GTP-U-1] Interfaces with GTP-U tunnels	02	• Added information about interfaces with GTP-U in 5GC - N3: between gNB and UPF - N9: between different UPFs
[Section 3.5] GTP-U packet format	02	• Added description about processes on DSCP marking of outer IPv6 header. • Added PPP/PPI field in PDU Session Container based on update of TS 38.415

DMM WG (draft-hmm-dmm-5g-uplane-analysis)

- @IETF103 (00 à 01)

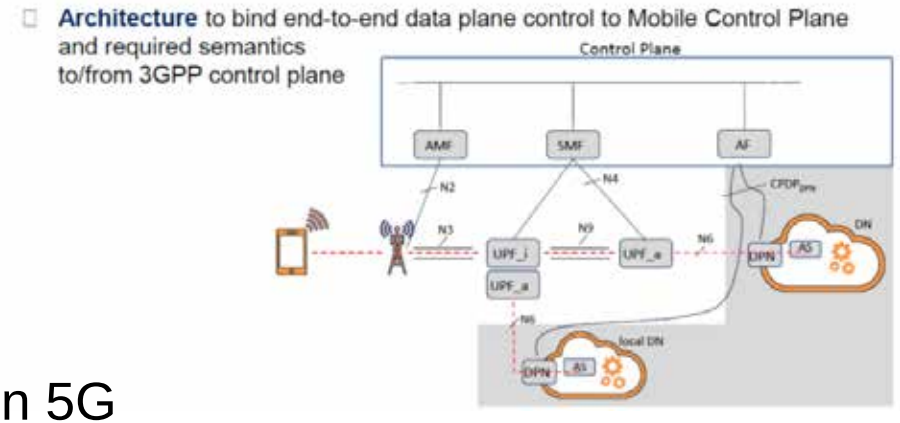
Major Updates (Cont.)

Object	Ver.	Update Details
[Arch-Req-2] Considera-tion on IP connectivity	01	• Added recommendation to use IPv6 for building network and consideration on interoperability with legacy networks.
[Arch-Req-4] Possibility of effective routing	01	• Described possibility of optimizing routing by connecting UPFs distributed geographically.
[Arch-Req-6] Process of DSCP marking of outer IP	01	• Complemented DSCP marking process: - QFI is indicated from SMF to UPF - UPF marks outer DSCP based on QFI contained EH
[Arch-Req-7] Overview of slicing arch in 3GPP	01	• Added overview of slicing architecture in 3GPP: - Slice is composed of SMF, RANs, UPFs, and DNs. - Transport network is out of scope

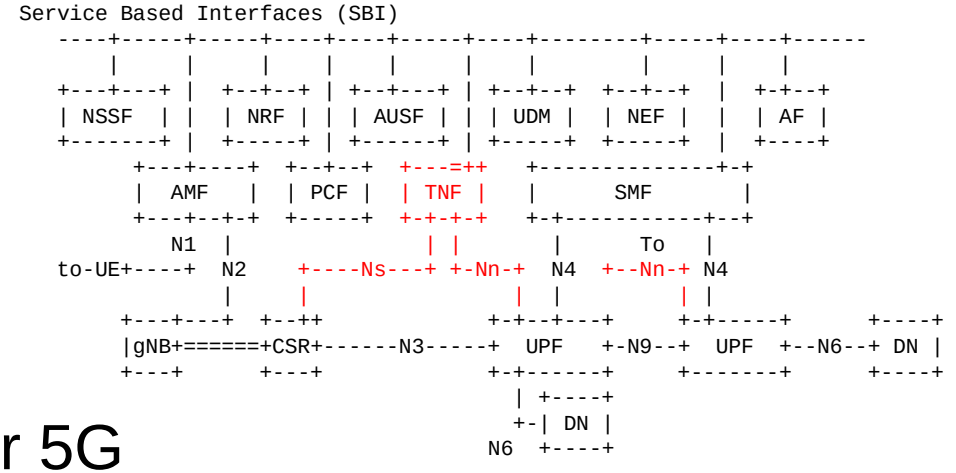
DMM WG (各ドラフトの主な進捗/続き)

- *これら Individual draft などは参考ということで*
- draft-fattore-dmm-n6-cpdp-trafficsteering
  - Mobility 環境下で Cloud も最適なものを選択できるような仕掛けが必要ということで、AF(Application Function)にて N6 policy定義を提案

https://datatracker.ietf.org/meeting/103/materials/slides-103-dmm-control-data-plane-for-n6-traffic-steering-00



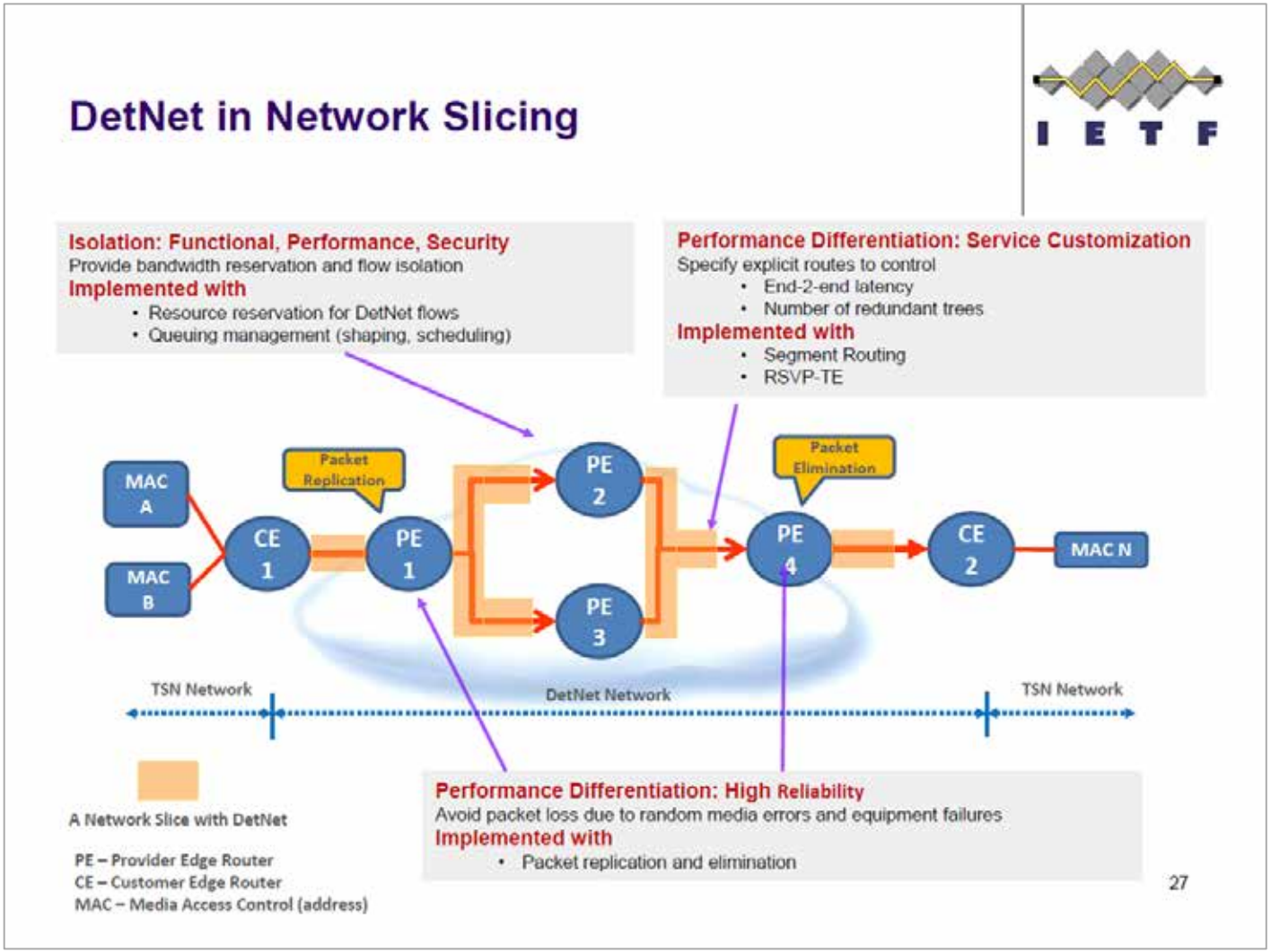
- draft-clt-dmm-tn-aware-mobility
  - Transport Network aware mobility in 5G
  - Underlay(Transport)に SR-TEとしてSPRING, LSRで提案されている Preferred path routing (PRR) を用いた提案



- Time Sensitive Networking for 5G
  - ドラフト紹介でなく、課題提起。低遅延も考慮すべきという主旨
  - 実は、IEEE TSNで紹介のあったもの à なので DetNetにバトン J

Time Sensitive Networking for 5G

- http://www.ieee802.org/1/files/public/docs2018/detnet-tsn-grossman-detnet-use-cases-1118-v01.pdf



DETNET WG

DetNet WG とは

- **Deterministic Networking**
  - L2, L3 networkにおいて、低遅延、低ジッタ(delay variation)を実現するためのネットワーキングを検討
    - 5G Networking の要求沿ったネットワーク検討
  - IEEE 802.1 TSN (Time sensitive networking) と連携
  - IETFのWGなので、L3観点(IP, MPLS)で検討
- **現在の状況(今回の進捗)**
  - Architecture, Use case, Problem Statement はIESGに ()
  - Encapsulation は IP, MPLSにて、仕様進行中
    - draft-ietf-detnet-dp-sol-{mpls/ip} à 次ページ
  - 現在の大きな課題はDetNetにおけるQoSならびに優先制御の考え方
    - draft-xiong-detnet-qos-policy
    - draft-finn-detnet-bounded-latency など
  - 他 Security, YANG/Information modelなど
- 今回の目玉は、11/11(日)に開催されたIEEE802.1 TSNとの合同WS(後述)
  - https://1.ieee802.org/tsn/tsn-task-group-agenda/#Sunday_DetNet_8211_TSN_joint_session
  - 以下、WG進捗資料も

[detnet] draft-ietf-detnet-dp-sol-{mpls/ip}

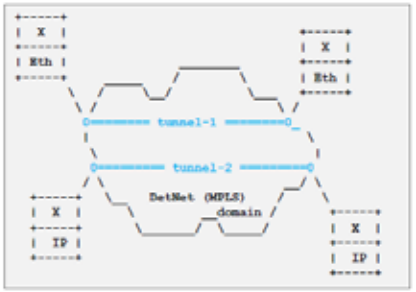
- Overview

Data plane
MPLS and native IP networks

Data flows over DetNet network
- L2 → DetNet Layer 2 service
- L3 → DetNet Routing service

Data plane for DetNet over
- an MPLS-based Packet Switched Network (PSN)
- an IP-based Packet Switched Network (PSN)

DetNet functions require flow attributes from data plane
- Flow-ID
- Sequence number



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Overview
DetNet essentials

- DetNet
  - operates at the IP/MPLS layer
  - is for networks that are under a single administrative control or within a closed group of administrative control.
  - is NOT for large groups of domains such as the Internet.
- DetNet service provides a capability for the delivery of data flows with
  - (1) extremely low packet loss rates and/or
  - (2) bounded end-to-end delivery latency

Note1: These characteristics are accomplished by dedicating network resources such as link bandwidth and buffer space to DetNet flows and/or classes of DetNet flows, and by protecting packets (e.g., by replicating them along multiple paths.
Note2: Unused reserved resources are available to non-DetNet flows as long as all guarantees are fulfilled.

Boldizs Varga | 2018-11-11 | DetNet - Data plane and related functions | Page 3

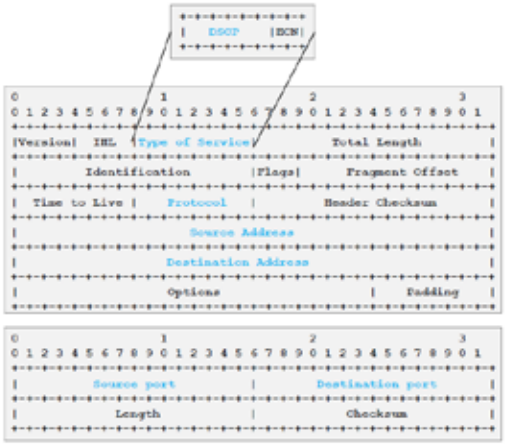
http://www.ieee802.org/1/files/public/docs2018/detnet-tsn-varga-detnet-basic-concepts-1118-v01.pdf
(次スライドも)

[detnet] draft-ietf-detnet-dp-sol-{mpls/ip}

- **フォーマット/Flow定義**

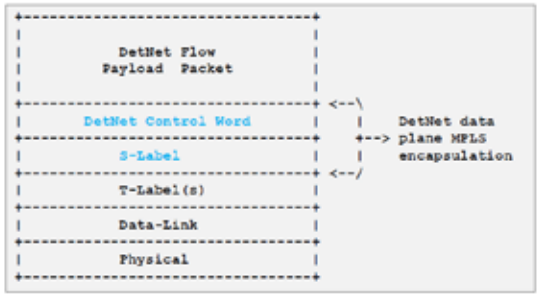
IP data plane – Flow identification
6-tuple

- Flow identification
  - based on IP (both IPv4 and IPv6) header information.
  - "6-tuple": the traditional 5-tuple + DSCP
    - IP source and destination address fields,
    - the next level protocol or header field,
    - the next level protocol specific fields (e.g. TCP or UDP source and destination ports or IPSec AH/ESP SPI field)
    - the IPv4 Type of Service or IPv6 Traffic Class field (i.e., DSCP)
  - any of the fields can be ignored (wildcarded), and bit masks, prefix based longest match, and ranges can also be used
  - Under discussion:
    - IPv6 flow label, other upper layer protocol header information



MPLS data plane – Encapsulation
DetNet PW

- MPLS-based DetNet data plane encapsulation:
  - DetNet control word (d-CW) containing sequencing information for packet replication and duplicate elimination purposes, and the OAM indicator.
  - DetNet service Label (S-label) that identifies a DetNet flow to the peer node that is to process it.
  - Zero or more MPLS transport LSP label(s) (T-label) used to direct the packet along the label switched path (LSP) to the next peer node along the path.
  - The necessary data-link encapsulation is then applied prior to transmission over the physical media.



- DetNet Flow identification
  - at a DetNet service sub-layer is realized by an S-label
  - S-label is allocated from the platform label space
  - S-label MUST be at the bottom label of the label stack and MUST precede the d-CW

draft-ietf-detnet-yang

- YANG**は省略するが、**DetNet Topology Model (Link, Node, Termination point), DetNet Flow Configuration Model, DetNet QoS Model**を定義**
- DetNet flow**の構成は以下の通り**

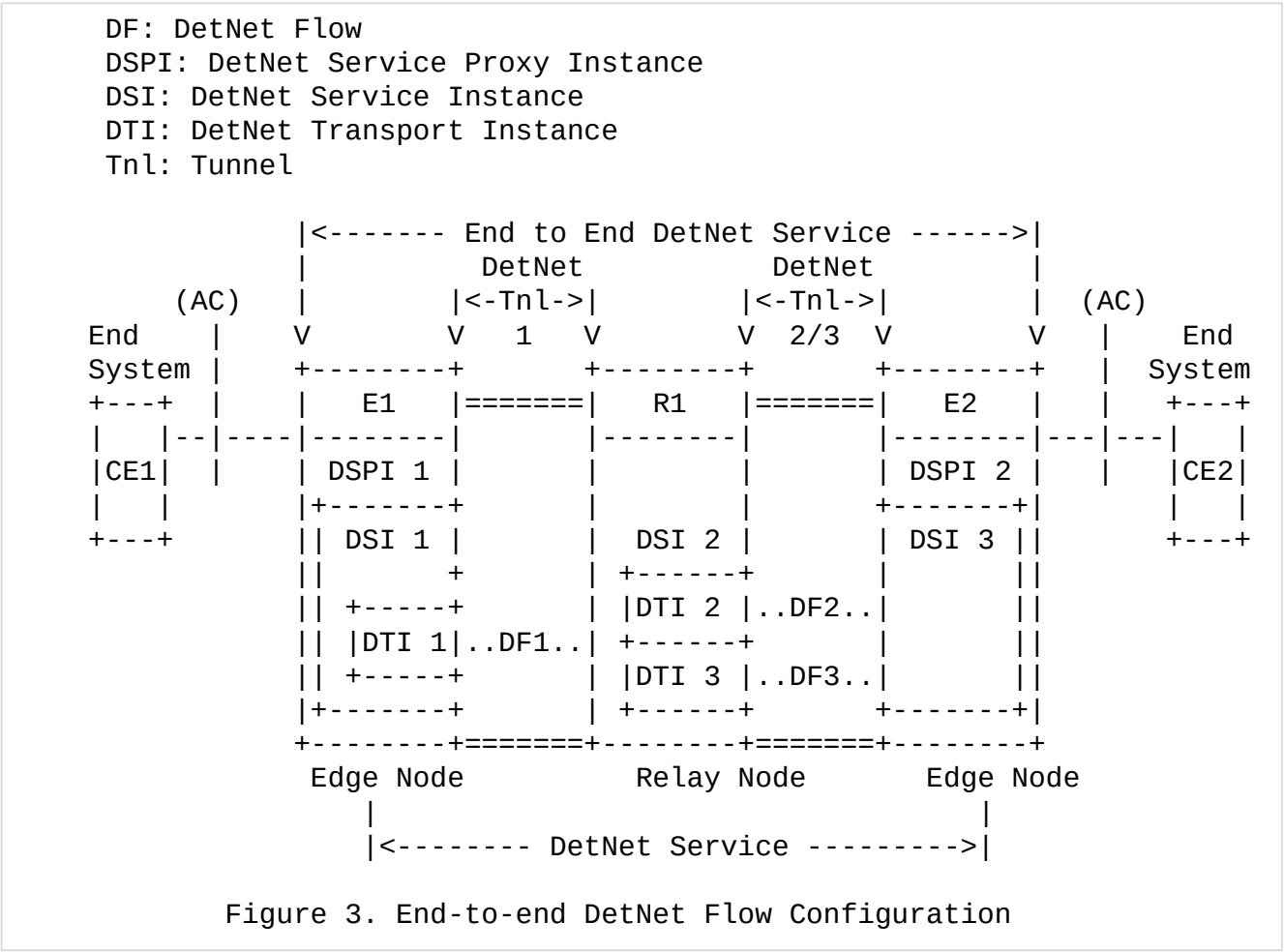
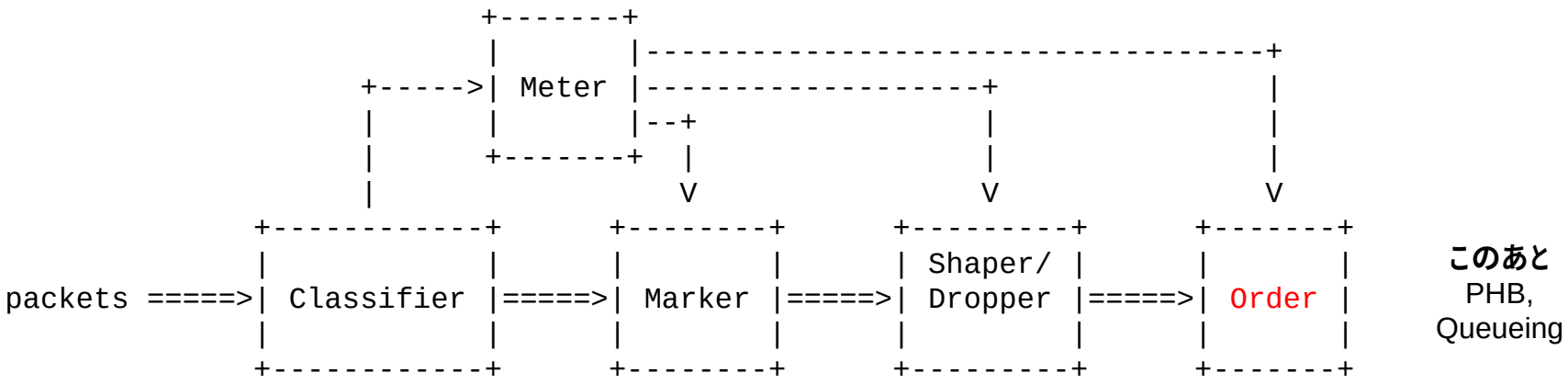


Figure 3. End-to-end DetNet Flow Configuration

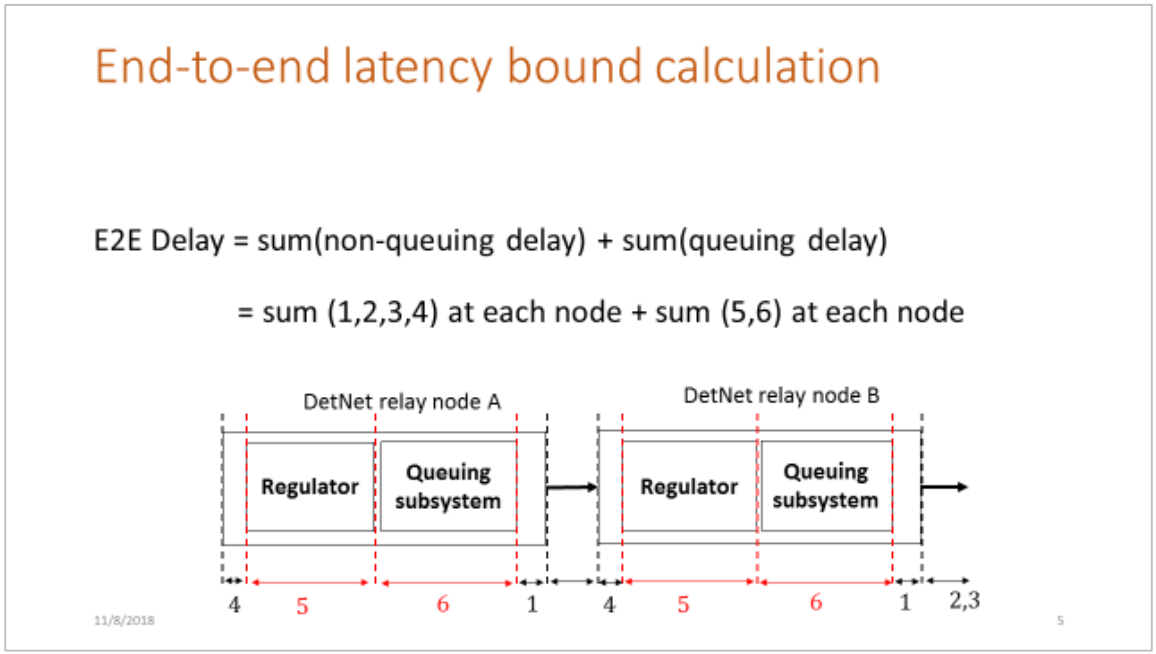
[DetNet]draft-xiong-detnet-qos-policy-00

- **ドラフトにて、提案している**DetNet DiffServ mechanism
  - DetNet Flow**要求**(non-DetNet Flow**との識別など)に基づき、** RFC2475**定義の** classifier and traffic conditioner**をベースに対応として、**Order(i.e. Sequence number)**を定義**
  - **既存**MPLS(RFC3270)**と異なる、**DiffServ**定義を行うのか?、という質問/確認のコメント多数**



draft-finn-detnet-bounded-latency-02

- IETF102**あたりから提案されたドラフト**
- IETF**にて、定量化されたタイミングモデル**(Parameterized timing model)**を定義/モデル化し、ゆくゆくは、**bounded latency **や** zero congestion loss**を考慮したパケット制御 などを実現するもの**
  - **注意すべきは、**IETF**ドラフトといいつつ、**IEEE TSN**で既定の**Queue**モデルを取り込みたい意図が見て取れる (特に、**IEEE Std 802.1Qch-2017)
- Relay system model**ならびに**End-to-end Latency Bounds**計算例**

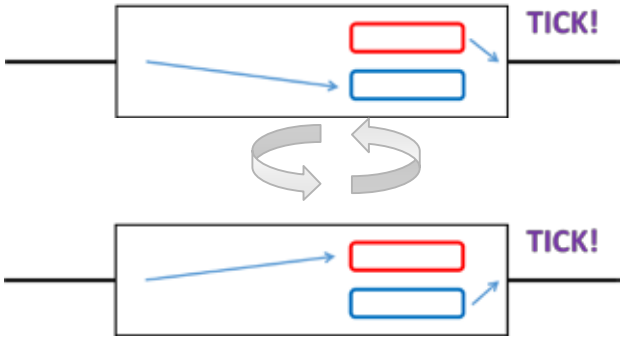


https://datatracker.ietf.org/meeting/103/materials/slides-103-detnet-07-detnet-bounded-latency-02

- draft-chen-detnet-sr-based-bounded-latency**が一例**

draft-chen-detnet-sr-based-bounded-latency

- Segment Routing (SR) to implement bounded latency.
  - Cyclic Queuing and Forwarding (CQF) (IEEE802.1Qch)**動作を、SRに適用し、バッファ動作のサイクルリストをSRの中で定義することで、低遅延伝送を目指すもの**



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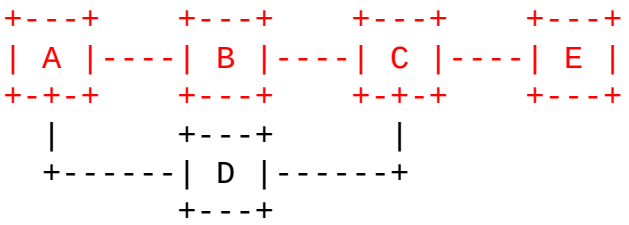



```
A   |---X---+-------+-------+-------+-------+-------+-------|

B   |-------+-------+---X---+-------+-------+-------+-------|

C   |-------+-------+-------+-------+---X---+-------+-------|

E   |-------+-------+-------+-------+-------+-------+---X---|

     cycle1  cycle2  cycle3   cycle4  cycle5  cycle6  cycle7

     DetNet path: A->B->C->E
     Specified cycle list <1, 3, 5, 7>
```

Figure 5: CSQF Example

IEEE/IETF合同WS

- 11/10(土)ならびに11/11(日)に開催
  - 11/10
    - Data Center Workshop
      https://1.ieee802.org/802-nendica/802-ietf-workshop-data-center-bangkok/
  - 11/11
    - DetNet - TSN Workshop
      https://1.ieee802.org/november-2018-plenary-meeting-in-bangkok-thailand-tsn-tg-agenda/
- 本日詳細は割愛するが、DC WSはこんな感じ(参考)
  - IEEEからは、Congestion control に関する動向紹介
    - P802.1Qcz Congestion isolation 中心に802.1Qbb -Priority-based Flow Control, 802.1Qau -Congestion Notificationを紹介
  - IETFからはRIFT WGで取り組んでいるRIFTという大規模DC向けルーティングプロトコルを中心に紹介 (draft-ietf-rift-rift)
    - LSVR WGで取り組んでいるBGP-LS拡張によるSPF提供は触れられず、代わりにdraft-ymbk-lsvr-lsoeのEditorがLink Discoveryに関して紹介
    - L4S (Low Latency, Low Loss, Scalable Throughput)に関するプレゼもあった。TSVWGで議論されているdraft-ietf-tsvwg-l4s-archなどのドラフト
  - https://mentor.ieee.org/802.1/dcn/18/1-18-0083-00-ICne-minutes-of-ieee802-ietf-workshop-on-dcns.pdf

(参考: Agendaなど)

DetNet –TSN WS Agenda

November 2018 Plenary Meeting in Bangkok, Thailand – TSN TG Agenda

Agenda overview is available here.

Sunday: DetNet – TSN workshop

The IETF DetNet WG and the IEEE 802.1 TSN TG had a workshop in Bangkok on November 11 Sunday.

Contact: detnet-chairs@ietf.org

	Subject	Discussion Leader	Affiliation	Length
8:00-10:00	AM1			
	Introduction & Meeting Objectives (IEEE-SA & IEEE 802 participation)	Lou Berger	LabN Consulting LLC	20
	Please register your attendance at IMAT while connected to meeting WiFi	János Farkas	Ericsson	
	Working/Task Group Overview			
	TSN TG overview	János Farkas	Ericsson	15
	DetNet WG overview	Lou Berger	LabN Consulting LLC	15
	Basic Concepts and Services			
	TSN (with Q&A)	János Farkas	Ericsson	30
	DetNet (with Q&A)	Balázs Varga	Ericsson	30
	Break			30
10:30-12:30	AM2			
	Flow Definition and Identification, QoS Service definition and parameters			
	TSN	Norm Finn	Huawei	30
	DetNet	Balázs Varga	Ericsson	30
	Discussion: DetNet/TSN Flow/QoS mapping			
	Mapping between DetNet and TSN	Norm Finn	Huawei	30
	Discussion	Norm Finn	Huawei	40
	Lunch break			60
13:30-15:40	PM1			
	Configuration and Control			
	TSN: SRP, LRP, RAP, and YANG	Feng Chen	Siemens AG	20
		Norm Finn	Huawei	
		Rodney Cummings	National Instruments	
	DetNet: Control plane tomorrow	Lou Berger	LabN Consulting LLC	30
	DetNet: YANG today	Mach Chen	Huawei	
	Break			20
16:00-18:00	PM2			
	Security			
	DetNet and TSN security	Tal Mizrahi	Huawei Network.IO Innovation Lab	30
	Discussion			10
	Applications & Use Cases			
	DetNet Use Cases	Ethan Grossman	Dolby	20
	IEC/IEEE 60802 TSN Profile for Industrial Automation	Ludwig Winkel	Siemens AG	20
	IEC 61850-90-13 Deterministic Networking for Power Automation	Malik Seewald	Cisco	20
	TSN for Service Provider Networks	Tongtong Wang	Huawei	20
	Key Takeaways and Next Steps (last slide)	Lou Birger	LabN Consulting LLC	10
		János Farkas	Ericsson	

会場など

IEEE/IETF合同WS – DetNet/TSN

- IETFでは、主に、DetNetのIPないしはMPLS Encapのドラフトについて紹介(Flow定義も含む)、
  - さらにDetNet Securityについて紹介が中心
  - CP/MP関連ということで、GMPLS, TEAS, PCEといったWGも紹介した
- IEEEでは、TSN での紹介
  - IEEE802.1CBの他、802.1Qci, 802.1Qchを中心に紹介
    - 特にCyclic Queuing and Forwardingについて時間を割いて紹介していた。
  - その他、設定関連(CP/MP関連)ということで、RAP: Resource Allocation Protocol (IEEE P802.1Qdd), LRP: Link-local Registration Protocol (P802.1CS)も紹介
- 課題(今後の方向性)としては
  - DetNetで定義されているL2/L3レイヤが、どうIEEE802.1Q TSN(802.1Q)L2レイヤと連携されるべきか(できるか)の検討が求められる
  - Flow IDの観点なり、QoSの観点や、他、Frame/packet replication and Eliminationの観点などでよりまとめることに
  - 主にDetNetで進めることになりそうなので、TSNをどう使うかについては、IETFでより検討されることにそう
    - 次スライド “Takeaways” 参照

IEEE/IETF合同WS – DetNet/TSN

- Takeaways
  - http://www.ieee802.org/1/files/public/docs2018/detnet-tsn-farkas-chairs-intro-1118-v03.pdf

Key Takeaways and Next Steps

- Some general agreements
  - Each technology should stand on its own within its scope
  - When used together/concurrently, duplicate mechanisms should be minimized (where it makes sense)
    - While maximizing alignment and compatibility
  - When possible, should leverage each other's efforts even when not used together
  - Both are working in parallel -- optimization may not be possible, but remains an objective
- To be documented and discussed in the short term
  - Document DetNet over TSN operation for routers and end-stations [DetNet WG]
  - Mapping DetNet traffic markings to TSN Stream ID [DetNet WG]
  - Mapping DetNet service parameters to TSN queuing mechanisms [DetNet WG]
    - N:1 stream aggregation (network calculus for bounded latency, and queuing) [Joint]
  - Alignment of YANG models [Joint]
  - IEC/IEEE 60802 DetNet requirements [Joint]

  Question: How do we coordinate joint work?
- Longer term topics
  - Document optimized TSN aware DetNet end-station
  - DetNet/TSN control plane interworking

Mapping DetNet to TSN（例）

- http://www.ieee802.org/1/files/public/docs2018/detnet-tsn-varga-detnet-basic-concepts-1118-v01.pdf

Mapping to TSN – IP/MPLS data plane
Concept

- Goal:
  - TSN functions have to identify flows those require TSN treatment (i.e., VLAN/dst-MAC)
- Concept:
  - DetNet Flow and TSN Stream mapping is based on the active Stream Identification function, that operates at the frame level.
  - E.g.,
    - Function 1 could be the Active Destination MAC and VLAN Stream identification
    - Function 2 could be the IP Stream identification
  - Protocol interworking required at both (ingress and egress) end of a TSN sub-network
- Note: Work in progress to extend stream identification (IEEE P802.1CBdb)

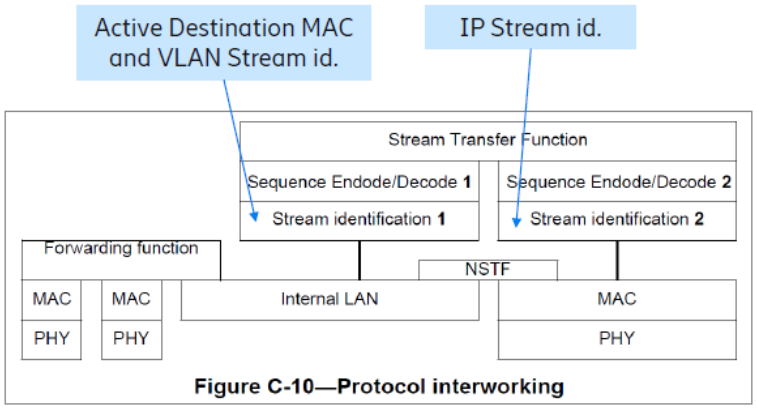
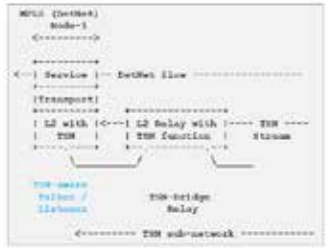


Figure C-10—Protocol interworking

Mapping to TSN – TSN-aware
DetNet nodes with TSN functions (MPLS example)

- Mapping:
  - TSN capable MPLS (DetNet) nodes are TSN end stations
  - Maps DetNet flows to/from TSN Streams
- TSN end station required capabilities includes the following TSN components:
  - For recognizing flows:
    - Stream Identification (MPLS-flow-aware)
  - For FRER used inside the TSN domain, additionally:
    - Sequencing function
    - Sequence encode/decode function
  - For FRER when the node is a replication or elimination point, additionally:
    - Stream splitting function
    - Individual recovery function

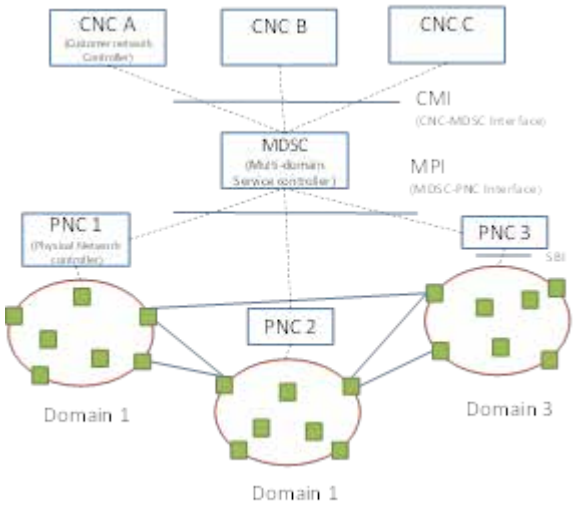


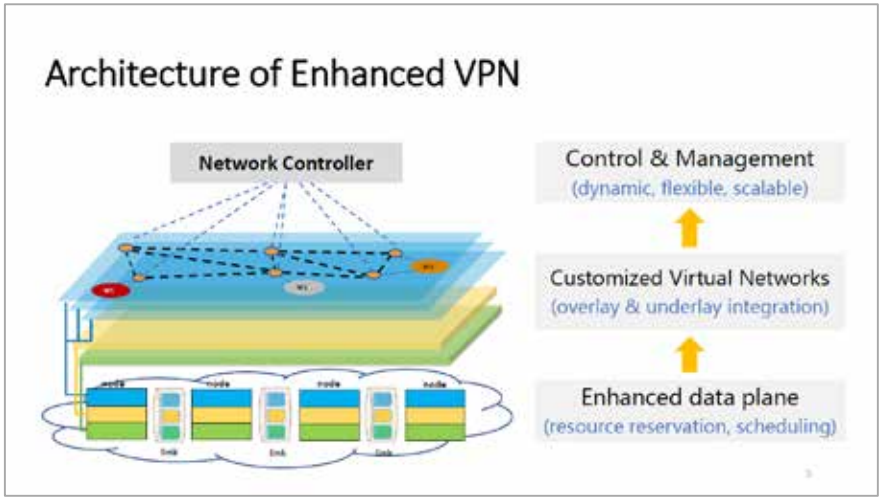
TSN-UnawareもDetNetで検討予定

TEAS (またはSlice関連)

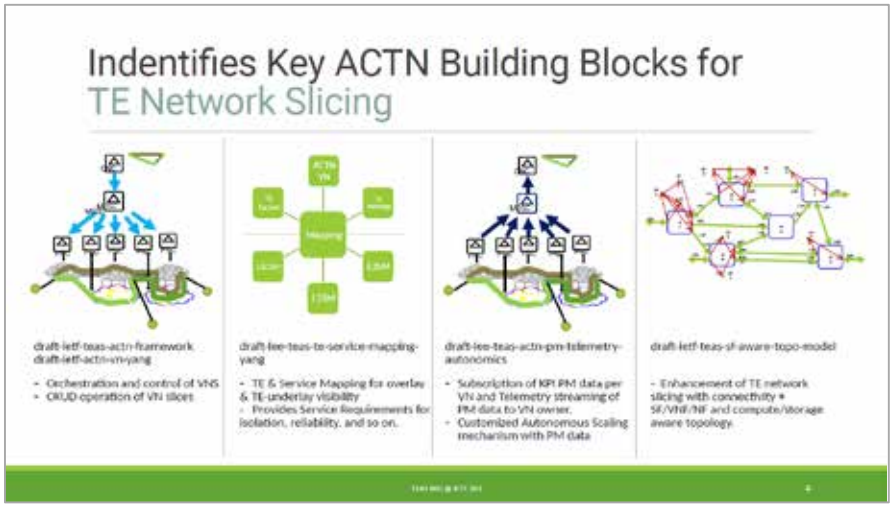
TEAS進捗

- **Traffic Engineering Architecture and Signaling WG**
- ACTNに関わるYANGが占めていた
  - RFC8453: Framework for Abstraction and Control of TE Networks (ACTN)
- **今回、2つのスライス(RTGWGまで含めると3つ)に関わるドラフトがマージが合意**
  - draft-king-teas-applicability-actn-slicing-04
  - *draft-lee-rtgwg-actn-applicability-enhanced-vpn-03*
  - draft-dong-teas-enhanced-vpn-02
    - à **draft-dong-teas-enhanced-vpn-03 に**





https://datatracker.ietf.org/meeting/103/materials/slides-103-teas-sessa-02-11-a-framework-for-enhanced-virtual-private-networks-vpn-02



https://datatracker.ietf.org/meeting/103/materials/slides-103-teas-sessa-02-10-applicability-of-abstraction-and-control-of-traffic-engineered-networks-actn-to-network-slicing-01

まとめ

まとめ

- これまで、連続で報告頂いた 5G時代に向けた(関わる)IPv6動向またはRTG Area 動向について紹介
  - DMM WG
    - Mobile SRv6などの進展
  - DetNet WG
    - 日曜日に行われた IEEE/IETF 合同Workshopも含む
    - DetNet/TSN Flow IDならびにQoS連携など
  - TEAS WG
    - VPN+ またはIETFにおけるスライス動向

- 個人見解として、共通に、5G時代向けネットワークに向け、インフラ(3GPP UPで下位)での活動に、今後も注目したい

ありがとうございました