

JICTON 2018



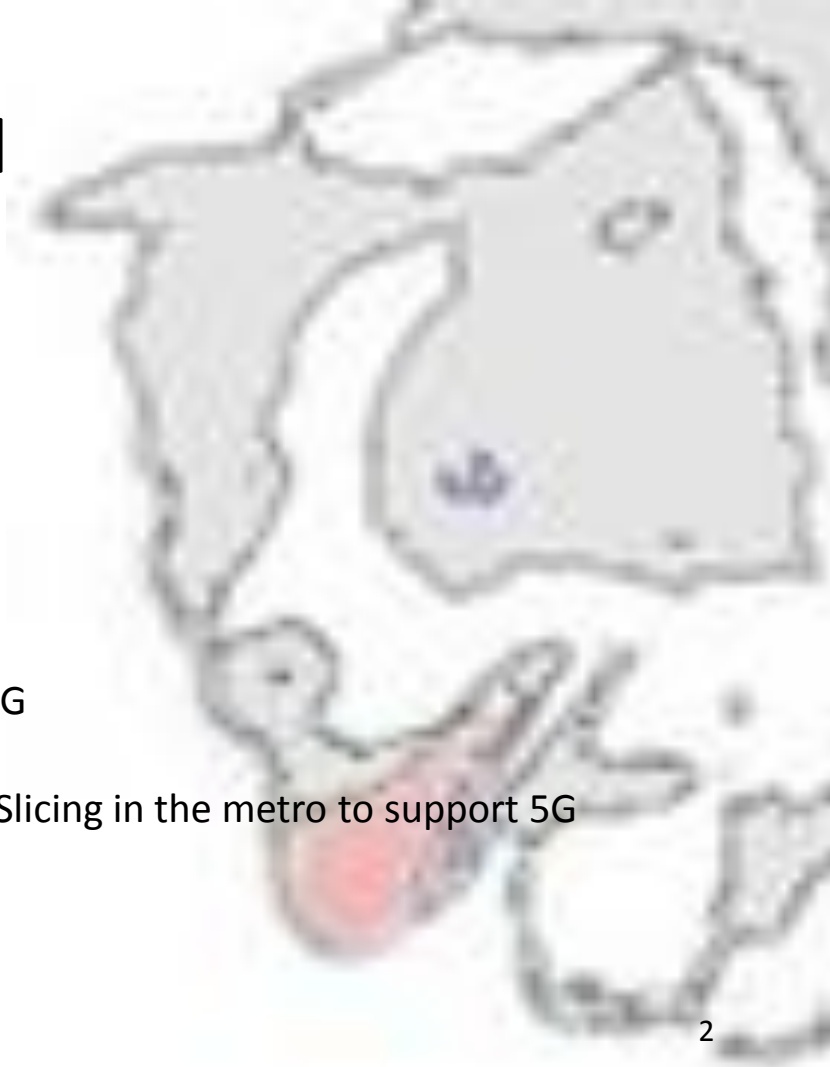
# Service Function Chaining (SFC) and Network Slicing in Backhaul and Metro Networks in Support of 5G

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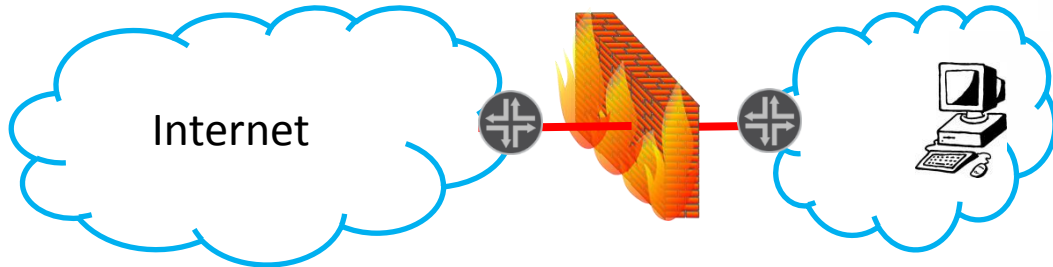
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    - What is the IETF standardising?
- *Plats principaux*
  - Evolving requirements on metro networks for 5G
- *Desserts*
  - Applying Service Function Chaining & Network Slicing in the metro to support 5G services
  - The METRO-HAUL project



# Classic Service Function Chaining

- “Bump in the wire”
  - Historically implemented as a dedicated device
  - In port and out port let it sit as an “invisible” feature on a link
- Many limitations
  - Large volume of under-used devices
  - Upgrades and new functions are hard
  - Management is highly distributed

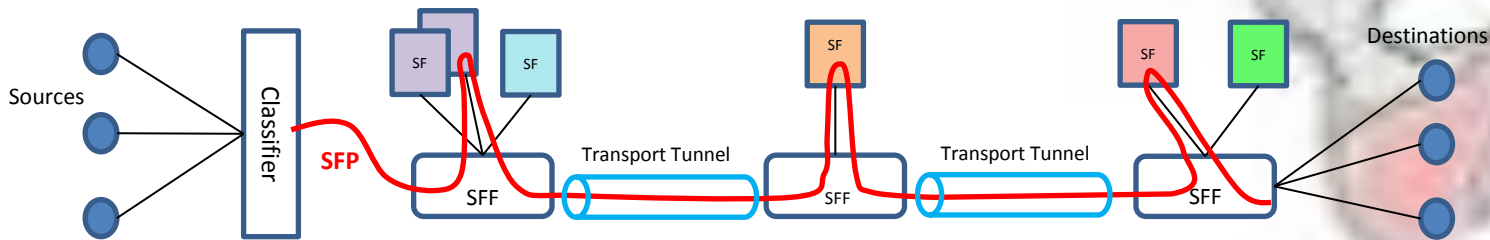


# Introducing the Data Centre

- Data centres allow service functions to be virtualised
  - Placed off-path
    - Means traffic has to be routed (tunnelled) to them
  - Achieves cost-effective scaling
    - One service function instance can serve many traffic flows
  - Achieves flexible scaling and load balancing
    - New service function instances can be spun up easily
  - Highly agile
    - New functions and new versions of functions can be rolled out
  - Simple management
    - Service functions are “local” to the management application and consistent

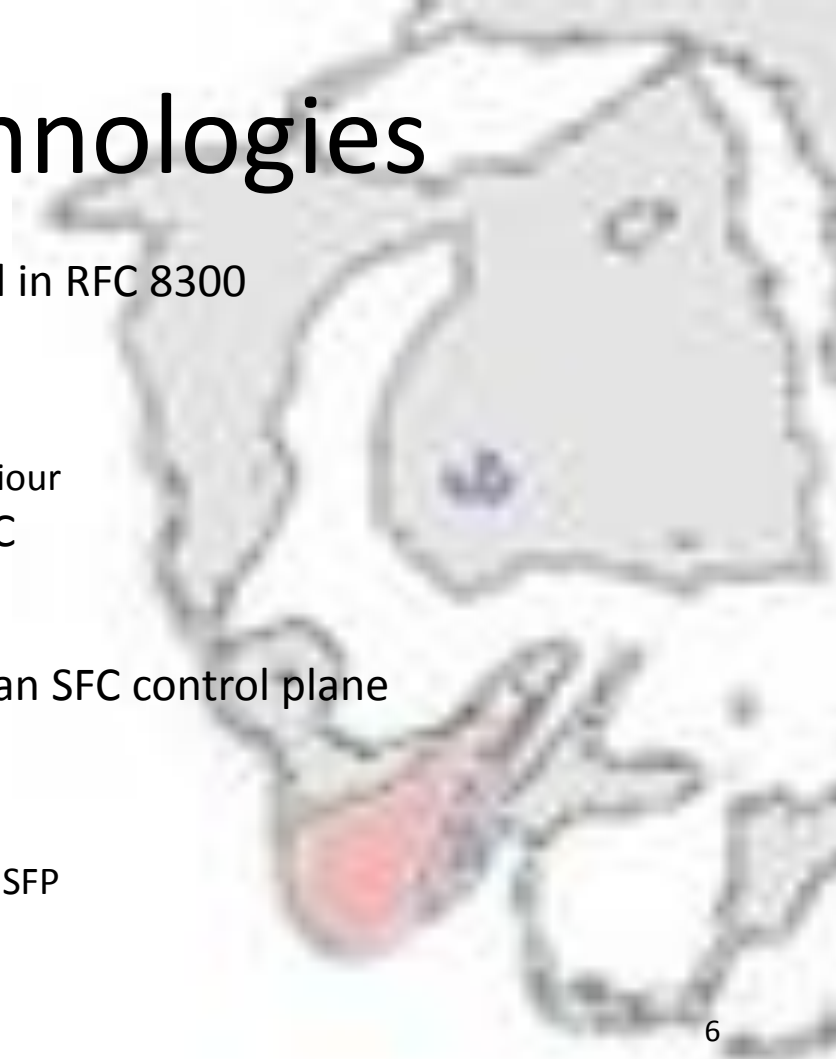
# The IETF's SFC Architecture

- Packets are classified to be processed by a chain of service functions
  - Placed onto a Service Function Path (SFP)
- Packets are tunnelled between Service Function Forwarders (SFFs)
  - Tunnels depend on local technology
  - SFFs and tunnels form an overlay network
- SFF delivers packets to locally instantiated Service Functions (SFs)
  - May be many instances for load balancing
  - May be many different types of SF attached to an SFF



# IETF's SFC Technologies

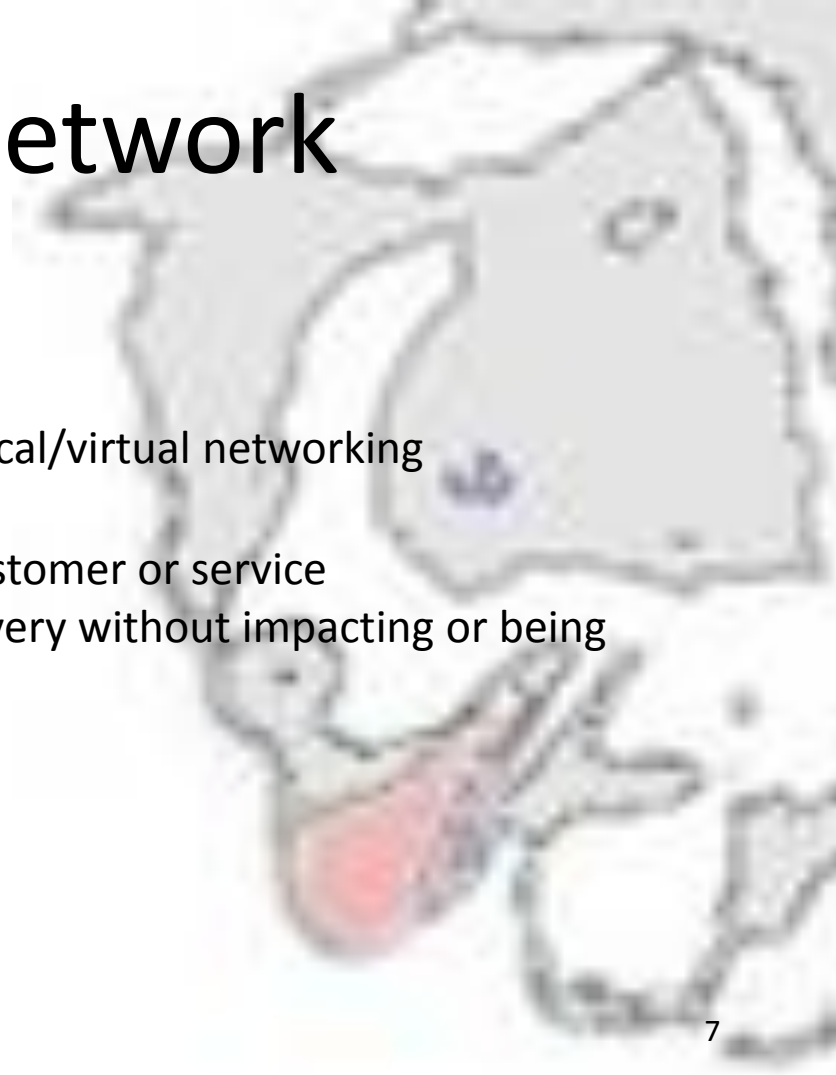
- Network Service Header (NSH) for SFC defined in RFC 8300
  - A layer network encapsulation
  - Transport and payload agnostic
  - Fields indicate which SFP and how far we have got
  - High function, but requires new forwarding behaviour
- draft-ietf-mpls-sfc re-uses MPLS to achieve SFC
  - Models the NSH in a pair of MPLS labels
  - Works for label swapping and MPLS-SR
- draft-ietf-bess-nsh-bgp-control-plane defines an SFC control plane
  - Based on BGP
  - Works for NHS and MPLS encodings
  - Discovers where SFs are located
  - Programs forwarding behaviour into SFFs for each SFP





# Slicing the Network

- Network resource separation
  - Not new
  - Consider overlay networks, VPNs and logical/virtual networking
- Network slicing
  - Reserving resources in a network for a customer or service
  - Aim is to guarantee a level of service delivery without impacting or being impacted by other services
  - “Resources” may be:
    - Bandwidth on links
    - Compute and storage
    - Service functions





# Network Slicing in More Detail

- Provide connectivity and function to serve customers with a wide variety of service needs
  - Low latency, reliability, capacity, and service function specific capabilities
- Requirements for Network Slicing
  - **Resources:** Partition the available network resources and provide specific Service Functions with correct chaining logic
  - **Network & Function Virtualization:** Virtualise physical resources and support recursive virtualisation
  - **Isolation:** Operate concurrent network slices across a common shared underlying infrastructure
    - **Performance:** Behaviour of one slice doesn't (can't) cause changes in behaviour of another slice
    - **Security:** Attacks or faults occurring in one slice must not have an impact on other slices. Traffic in a slice must be kept safe
    - **Management:** Each slice can be independently viewed, utilised, and managed as a separate network
  - **Control and Orchestration:** Orchestration is the overriding control method for network slicing
    - **End-to-end Orchestration:** End-to-end service delivery requires concatenation of networks
    - **Multi-domain Orchestration:** Services can be managed across multiple administrative domains





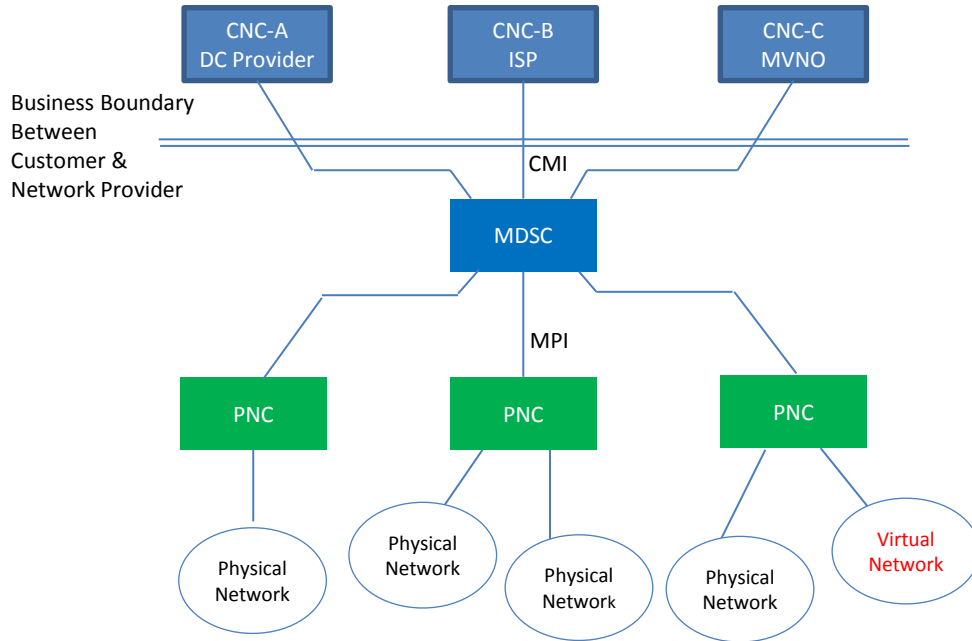
# Why Standards for Slicing?

- Standards are about ensuring interoperability
  - Protocol standardisation is well-known
  - Data models form an increasing part of standardisation
- Network slicing in the IETF is:
  - Use of existing tools to manage networks
    - Routing protocols can advertise link information
    - Signalling protocols can collect path information
    - BGP-LS can share network abstractions and PCE can compute overlays
    - Management protocols can partition and configure networks
  - Some architecture work
  - Abstraction and Control of Transport Networks (ACTN)
    - An architecture and data models to request, report, and control the virtualisation of transport networks for different applications and customers
      - draft-ietf-teas-actn-framework
    - Can easily be applied to network slicing
      - draft-ietf-teas-applicability-actn-slicing

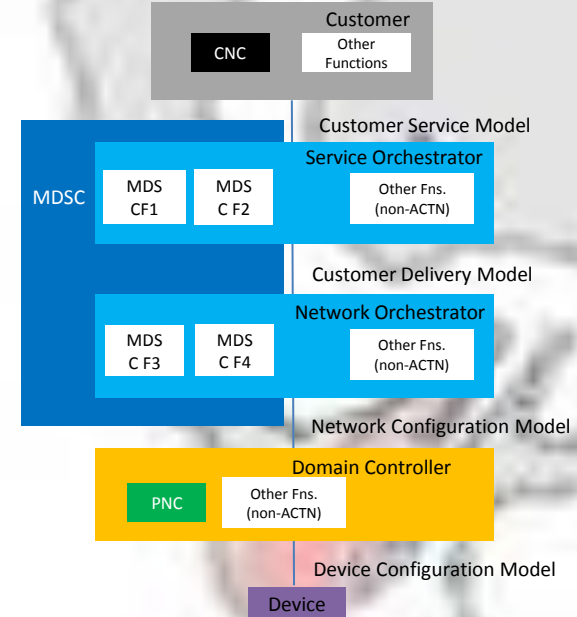


# Abstraction and Control of Transport Networks (ACTN)

## Base ACTN Architecture



## Functional Split of MDSC Functions in Orchestrators



# 5G Requirements on The Metro Network

## Low Latency

- Underpinned by fibre connections
- Service requirements (e.g., Ultra Reliable Low Latency Connection service)

## Capacities

- Wireless Channel Width (20MHz, 100MHz, etc.) & Modulation Order (e.g., 64 QAM, 256 QAM, etc.)
- Variable Bit-rate Optical Bandwidth to support “tidal” demands
- Sliceable optical network to separate services, applications, and customers

## Management

- Hierarchical Orchestration across Domain/Resource Controllers
- Automated end-to-end management
- Services delivered over resource slicing
- High-function diagnostics based on telemetry

These are essentially all slicing requirements

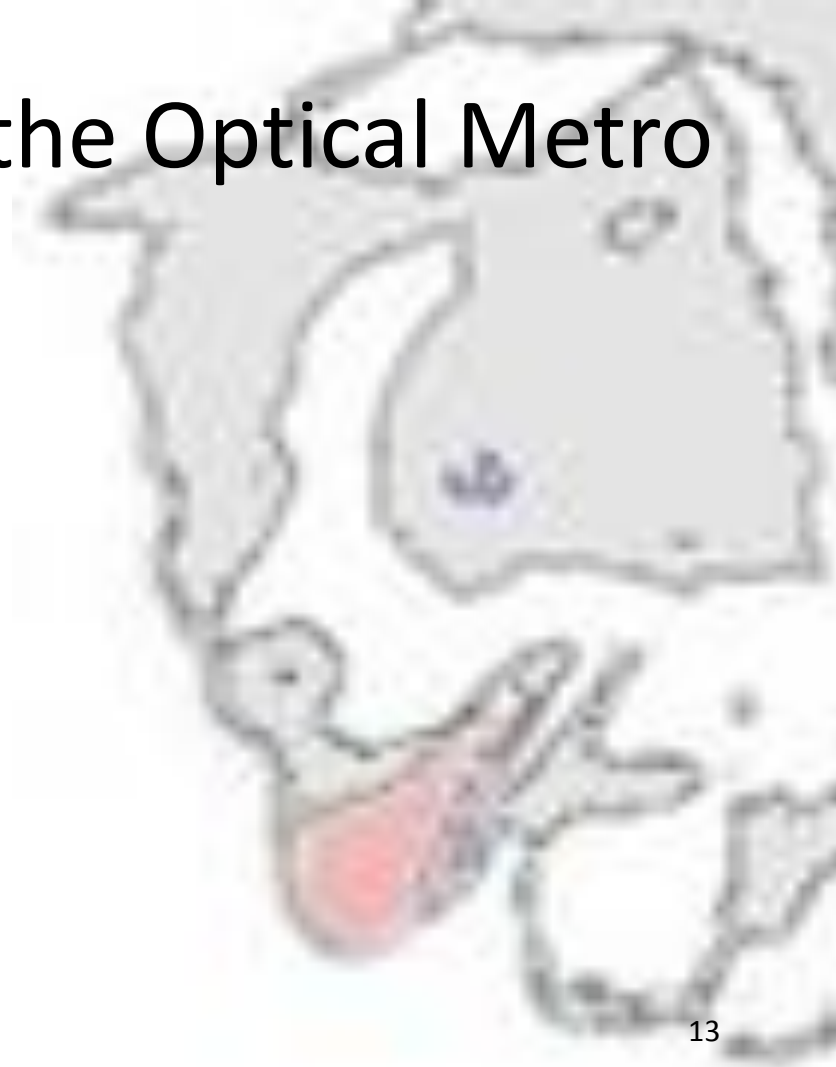


# Slicing and Chaining for 5G

- Worth noting as a side point that 3GPP has done a lot of work on slicing and SFC
- But this is focused on the RAN not the underlying metro or transport network

# Slicing and Chaining in the Optical Metro

- Slicing in the optical metro is relatively intuitive
  - Use SDN to partition optical resources
  - Build on tuneable, flexible optics (flexi-grid)
  - Build elastic virtual networks for different uses
  - Leverage whitebox optical devices
  - Use telemetry for advanced (predictive) diagnostics
  - Largely modelled on the IETF's ACTN toolkit
- SFC in the optical network is less obvious
  - Maybe consider virtual BBUs
  - Probably the SFC work exists at higher layers
  - Facilitated by the metro network
    - Connecting together metro data centres
    - Pulling function out of the core into the metro
    - Determining best location for service functions
    - Computing best paths between service functions
  - All part of the network slicing problem space



# METRO-HAUL

- EC-Funded project to design and build a smart optical metro infrastructure able to support traffic originating from heterogeneous 5G access networks
  - Addressing the anticipated capacity increase and its specific characteristics, e.g., mobility, low latency, low jitter etc., for next generation mobile applications
- 5G-PPP Phase 2 EU Project – started 1st June 2017
- H2020-ICT-2016-2 METRO-HAUL project (G.A. 761727) : Budget of Eight Million Euros
- Comprising of 20 core partners  
BT, Telecom Italia, Centre Tecnològic Telecomunicacions Catalunya (CTTC), Telefónica, University of Bristol, Polytechnical University of Catalonia (UPC), CNIT, NAUDIT, OpenLightComm, Lexden Technologies, Zeetta Networks, Fraunhofer HHI, Technical University Eindhoven, Coriant Portugal, Ericsson, Polytechnical University of Milan, ADVA, Nokia, **Old Dog Consulting**, SeeTec GmbH

# Metro-Haul Project Objectives

- Architect and design cost-effective, energy-efficient, agile and programmable metro networks
  - Scalable for 5G access and future requirements
  - Design of all-optical metro nodes (including full compute and storage capabilities)
  - Interface with both 5G access and multi-Tbit/s elastic core networks
- Challenges
  - Make metro optical transport cost effective and agile, using network architecture and innovative optical components
  - Design and implement an SDN/NFV control framework supporting 5G end-user and vertically oriented services, including slicing
  - AI-based tools for interpreting vast amounts of monitoring data
- Commercial Use Cases, including:
  - Video Security for Smart Cities
    - Intelligent video security based on automatic object/person identification and tracking
    - Video-based automated security system relying on stationary and mobile cameras with wired and/or wireless access
    - 5G Berlin testbed coupled with DT's Berlin metro infrastructure
  - Crowdsourced Video Streaming
    - Simultaneous sourcing of video from different individuals in an event with a large crowd
    - The different video sources need synchronising and clustering
    - Dynamic and controllable metro network essential



# Questions and Follow-up

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