

# ALTO Implementations and Use Cases: A Brief Survey

draft-chen-alto-survey-00

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# Goals and Scope

- Goals:
  - The system architectures of ALTO implementations and **possible issues**
  - Find current use cases and **future use cases**
  - **Research opportunities** (i.e., possible ALTO extensions)
- Scope:
  - ALTO implementations in different companies/institutions
  - Application scenarios of ALTO in literature work

# Methodology for ALTO Implementations

- Questionnaire
  - Basic Information
    - Project Name, Motivation, System Architecture, Implemented Map Services
  - Four Entities in ALTO Implementation
    - Data Source, ALTO Server, ALTO Client, Information Consumer
  - Benefits/Issues
    - Main Benefits of Using ALTO
    - Recognized Issues
- <https://docs.google.com/forms/d/1wAghp2luWADO7NwuTwOQBHJgCs05TBdyZm-qDCwWSBs/edit>

# Methodology for ALTO Application Scenarios in Literature Work (Papers/Projects/Patents/RFCs)

- Heavy paper reading and classification
- ALTO Survey Form
  - Classification of papers
    - Solution of Implementations/Deployments
    - Recommended Protocol -> Potential Use Cases
    - Compete with ALTO -> Research Opportunities
- For each paper/patent
  - Extend Standard ALTO or not?
  - How they use/mention ALTO
  - Challenges and Research Opportunities
  - Single/Multi Domains
  - Application Scenario
- <https://docs.google.com/spreadsheets/d/1dgbVApnyyiljbSFp49jSlz3XQHmbmme3WXMqfOZVpY0/edit#gid=0>

# Summary of Current Status (Implementations)

- The number of implementations: 6
  - ALTO Implementation in OpenDaylight
  - ALTO-based Broker-assisted Multi-domain Orchestration (University of Campinas)
  - Benocs: ALTO Implementation in Telekom (Benocs)
  - ALTO in SDN Mobile Networks (Mobile Innovation Center)
  - Network Positioning System (Cisco)
  - Unicorn: Multi-Domain, Multi-Controller Resource Orchestration (Tongji, Yale, Caltech)
- Potential companies which implemented ALTO
  - TATA
  - Canada Bell
  - May need WG members to help to get connected with more companies/institutions

# Summary of Current Status (Literature Work)

- Classification by application scenario (count)
  - P2P (31)
  - CDN (9)
  - SDN (11)
  - NFV/VNF (2)
  - Cloud (8)
  - Wireless (2)
  - Blockchain (1)
  - IoT (1)
  - Multi-domain (2)

# Summary of Current Status (Literature Work)

- Classification by ALTO functionality
  - Peer Selection
    - Peer Selection in P2P, Surrogate Selection in CDN, dCDN Selection, Cache Selection
  - Path Selection
    - Path Selection in MPTS-AR
  - Resource Placement
    - Virtualized Service Function Chain Placement, Intelligent Virtual Machine Placement, Service Placement in IoT
  - Measure Results Interfaces
    - ALTO as an Interface to Query on the LMAP measure results
- For existing use cases, please refer to <https://docs.google.com/presentation/d/1aXIZfUjQrSFhkVIUbvt2ouKWqLgGq4kbG-EBmSaZtKo/edit?usp=sharing>

# Summary of Current Status (Literature Work)

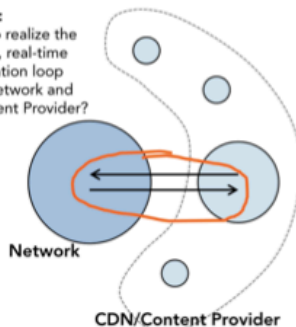
- Future Use Case 1: ALTO as Network Behaviors Exchanger between Provider
  - Mentioned by Bell Canada in PANRG – IETF 101

## Our Challenge on Path Awareness

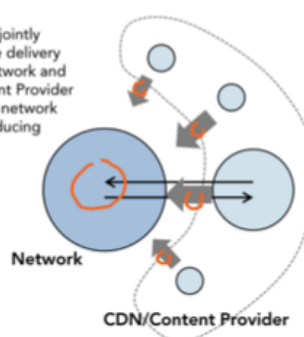
- We Are Getting Good At Telling the Edge How to Talk with the Network
  - From BGP extended communities to Binding SID and PvDs.
  - From SRTE in the control-plane to configuration via management plane (NC/gRPC).
- There is also progress on how to exchange network behaviors between providers
  - Use of ALTO to exchange network capabilities and requirements  
(<https://telecominfraproject.facebook.com/notes/tip-greenfield-networks-app-aware-networking/application-aware-networking-a-first-step-towards-intent-based-networking/1941364519455351/>)

### Use cases description:

Use case 1:  
We want to realize the  
automated, real-time  
communication loop  
between network and  
CDN/Content Provider?



Use case 2:  
We want to jointly  
optimize the delivery  
between network and  
CDN/Content Provider  
– improving network  
load and reducing  
latencies.



But how can an app or a host ask for a policy ?

PANRG – IETF 101 London



# Summary of Current Status (Literature Work)

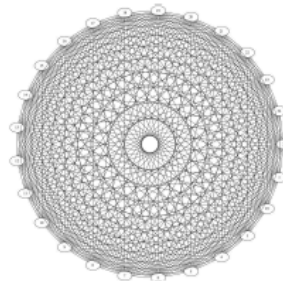
- Future Use Case 2: ALTO being Used to Solving  $n^2$  Problem
  - Mentioned By ESnet6 – Network Conceptual Design

## Tunnels are the Key Abstraction

The Packet Core will provide a full mesh of resilient tunnels connecting all Service Edges.



ESnet5: Hop-by-hop Routed along Physical Path



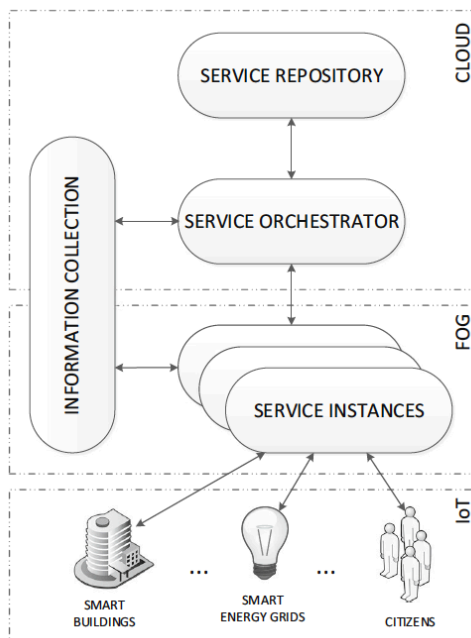
ESnet6: Full Mesh of **Logical** Tunnels

- **Simplifies the resiliency problem**
  - Topology changes affect dozens to hundreds of tunnels, instead of 100K+ routes.
  - So table update & synchronization will be faster
- **Provides more flexible traffic engineering controls**
  - Automatically lay-out, or individual control 1000s of tunnels, instead of just having metrics on less than 100 links.
- **Automation functions are needed to manage scale**
  - Full mesh of logical tunnels implies an  $n^2$  problem (where  $\sim 60 < n < \sim 120$  (single vs dual dataplane))
  - Tunnel management can be done “in-skin” as part of the router function (e.g. Segment Routing (SR)), and/or as part of external software suite (e.g. ALTO, PCEP, SDN)



# Summary of Current Status (Literature Work)

- Future Use Case 3: ALTO as Information Source of Service Placement in IoT
  - Velasquez, Karima, et al. "Service placement for latency reduction in the internet of things." *Annals of Telecommunications* 72.1-2 (2017): 105-115.



Proposed Server Placement Architecture for IoT

## 3.2 Information collection

The following module is the *Information Collection* module. This module will be in charge of gathering information from the network and about the interaction among the users and the services requested. This information, together with the metadata from the services, is going to influence the future locations of the service instances. To implement this module, an option is using the Application-Layer Traffic Optimization (ALTO) protocol [20, 21]. The ALTO protocol offers a mechanism to perform better-than-random peer selection in peer-to-peer (P2P) networks, by obtaining information about the underlying network that helps to create an optimal overlay network, for instance, grouping devices that are located closer to each other, thus reducing the response time in their communication. Among the pieces of informa-

However, the mechanism employed by SNMP has been reported to have limitations [23]. Thus, ALTO represents a better option for the *Information Collection* module.

# Summary of Current Status (Literature Work)

- Future Use Case 4: ALTO as a Service to Guide the Peer Connection in Blockchain
  - Davids, Carol, et al. "Research Topics related to Real-Time Communications over 5G Networks." (2016).

With blockchain technology as a support for Internet of Money (IoM) and an ever-increasing range of application domains ranging from asset management, IoT, insurance, and alternative coins, the underlying network protocols and network infrastructure need to address the timing requirements of blockchain-based applications. While current transaction rates in the Bitcoin network are modest, due to the design of Bitcoin itself, the extensions towards micro-payment schemes and proof-of-stake based consensus schemes require efficient peer-to-peer flooding protocols, such that blocks and transactions may efficiently reach all the corresponding peers. For the relatively simple existing protocols, with demonstrated performance only for peer sizes in the 4 digit ranges, scalability will become crucial in the future. Network assistance can be prototyped and designed in the short term, with existing approaches like Application-Layer Traffic Optimization (ALTO [4, 7]), and can guide the peer connection process thus improving the bootstrapping of the existing blockchain. Longer term strategic research is required for scaling up to millions of nodes that inter-operate through a blockchain.

# Summary of Current Status (Literature Work)

- Challenges and Research Opportunities
  - Extend endpoint address type (the rack switch number, data center specific identifier...)
  - Extend endpoint properties (memory, storage...)
  - A bidirectional exchange of information between networks and applications
  - Mistrust between entities
  - Use ALTO to provide NFV information

# Next Steps

- Step deeper into the most related literature work
- Continue to finish the draft
- Find out more potential future use cases, challenges, research opportunities
- Get comments from WG

# Backup Slides