



Topology and Network Resources Discovery Protocol for Content-Aware Networks

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Main objectives



The paper proposes and develops:

- **a protocol for topology and network resources discovery in a multi-domain media oriented distribution eco-system**
 - QoS enabled
 - spanning multiple IP domains
- starting from a previously defined architecture, the protocol is specified
- protocol design, implementation and some performance evaluation – shortly presented



CONTENTS

1. ALICANTE project architecture (short- high level description)
2. TNRD Protocol Specification, Design and Implementation
3. Conclusions



1. ALICANTE System Architecture

- **ALICANTE : New concepts (Future Internet – oriented)**
 - Content Aware Networking (CAN)
 - Network Aware Application (NAA)
- **Novel virtual CAN layer (Data Plane + Mgmt&Ctrl Plane)– on top of IP networks**
 - focused on multimedia distribution but not limited to,
 - Quality of Services (QoS) assurance with different levels of guarantees

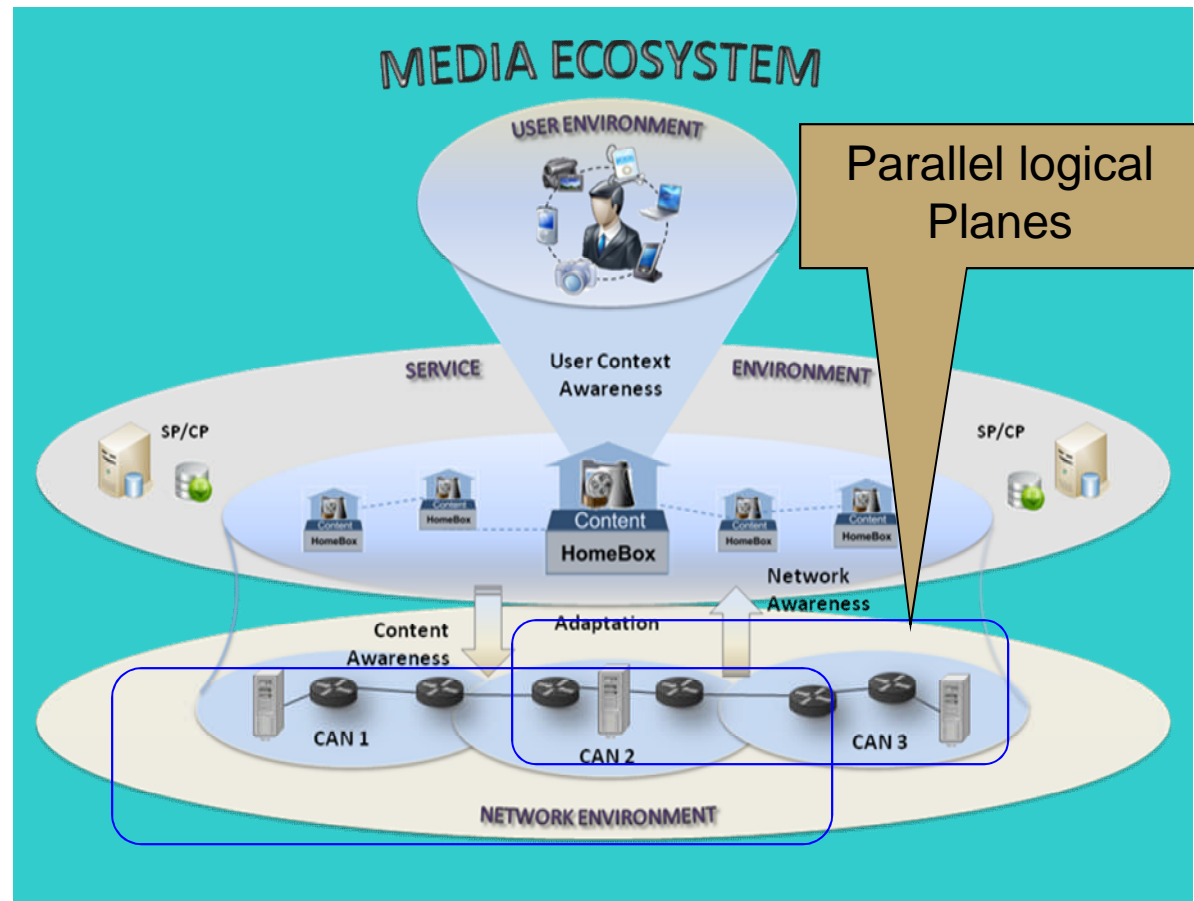
 - **In the Data Plane:** Create **Virtual Content Aware Networks (VCAN)**, multi-domain, unicast/ multicast and QoS enabled
 - at requests of high level **Services Providers (SP)** addressed to **VCAN Providers (CANP)**
 - VCANs: Implemented as *parallel logical data planes* customised for different content types
 - Content Awareness routing takes *content-type* or even *name* into account, not just *location address*

1. ALICANTE System Architecture (cont'd)

- Environments:
- *User (UE)* : End-Users terminals
- *Service (SE)*: Service and Content Providers
- *Network (NE)*, CAN Providers and Network Providers

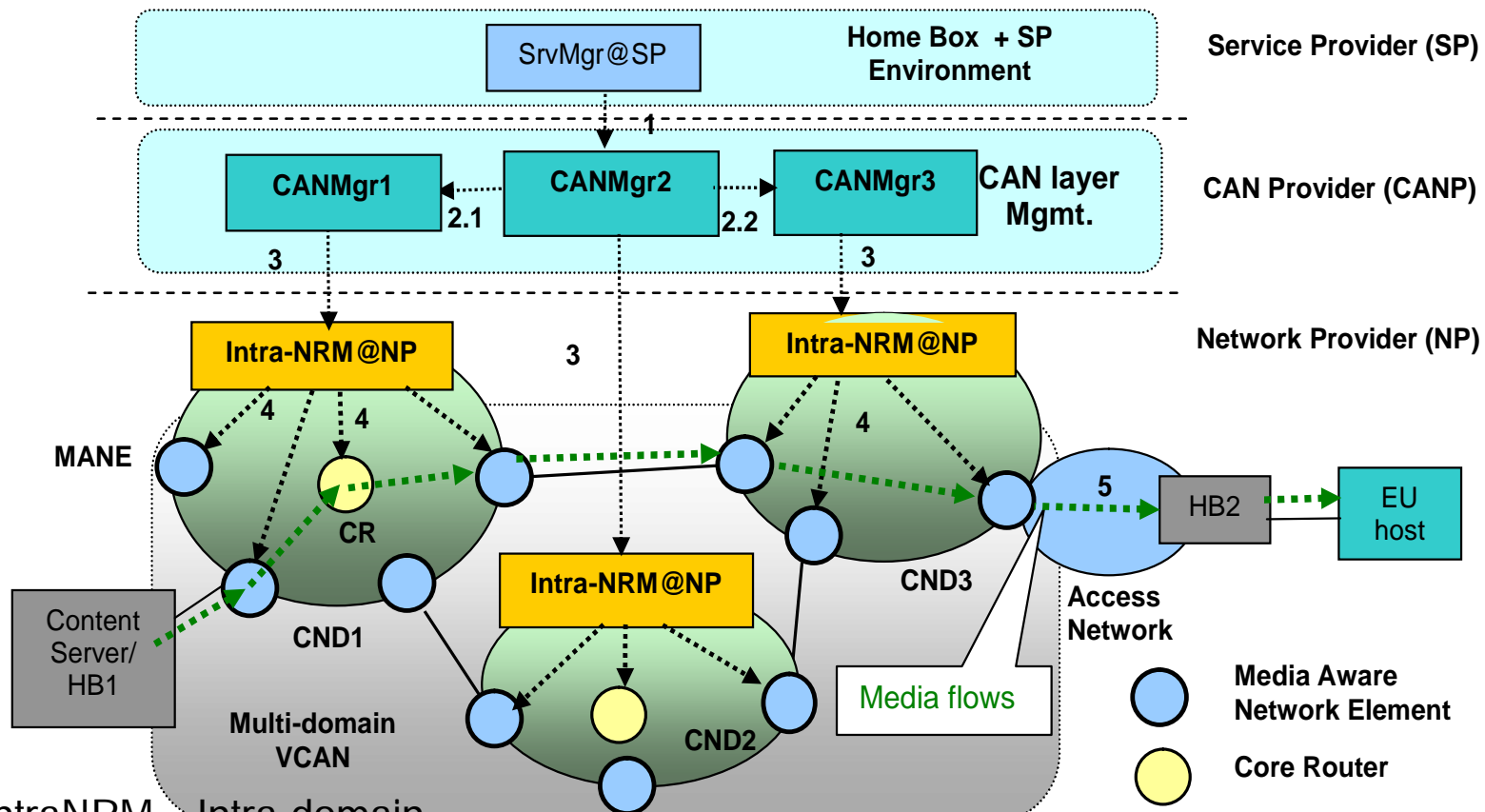
Actors:

- End-User (EU)
- Content Provider (CP)
- Service Provider (SP)
- Network Provider (NP)
- CAN Provider (CANP)



“Environment “: groups of functions defined around the same functional goal

1. Alicante System Architecture (cont'd)



IntraNRM – Intra-domain
Network Resource
Manager



1. Alicante System Architecture (cont'd)

CAN Manager workflow

1. Request from SP to create mono-multi-domain VCAN to an initiator CAN Mgr
2. CAN Managers negotiate horizontally for resource provisioning
 - TNRDP provides necessary information to support negotiations
 - Then a combined algorithm is used by CANMgrs to map the VCANs onto real network topologies
3. Commands are sent vertically to each IntraNRM for installing VCANs configurations in routers
4. Each IntraNRM send vertical commands to install network policies (ingress/egress) to MANEs and also to core routers



2. Topology and Network Resources Discovery Protocol

- CAN Manager needs information for building VCAN Mappings
 - Topological (multi-domain graph)
 - Resources (e.g bandwidth)
- Two possible modes of gathering information
 - On-demand – CAN Manager asks for info on each VCAN creation
 - Proactive – on timer/event, information is distributed over the network
- TNRDP proposal : proactive distribution of information between domain managers



2. TNRDP (cont'd)

Assumptions

- IntraNRM knows and transmits vertically information about internal paths (e.g based on pre-provisioned MPLS LSPs)
- Only CAN Mgrs participate in TNRDP
- TNRDP doesn't handle security/reliability
- CANMgr-s identities known statically, each one knows all its neighbors
- All domains are VCAN capable

TNRDP Requirements

- **Scalable** - in terms of traffic overhead/number of CAN Managers
- **Accessible** - any CANMgr can find out information about any part of the network
- **Parallel** – simultaneous changes in different parts of the network are handled
- **Stability** – information should be consistently updated if changes appear in different domains



2. TNRDP (cont'd)

Design

- Each CANMgr communicates directly to its neighbors and generates Network State Advertisement (NSA)
- NSAs are generated periodically or triggered by other messages
- Each NSA received by a CANMgr is combined with its own information and transmitted further
- “Hello” is used for connection keep-alive
- TNRDP is stateful
 - Each neighbor can be in either one of four states: Listen, Waiting for connect/disconnect confirm, Connected
- Any CANMgr may initiate Connect/Disconnect
- When a disconnect is received all info on links to that domain are erased
 - If this domain is a leaf one, then all info on this domain is purged.



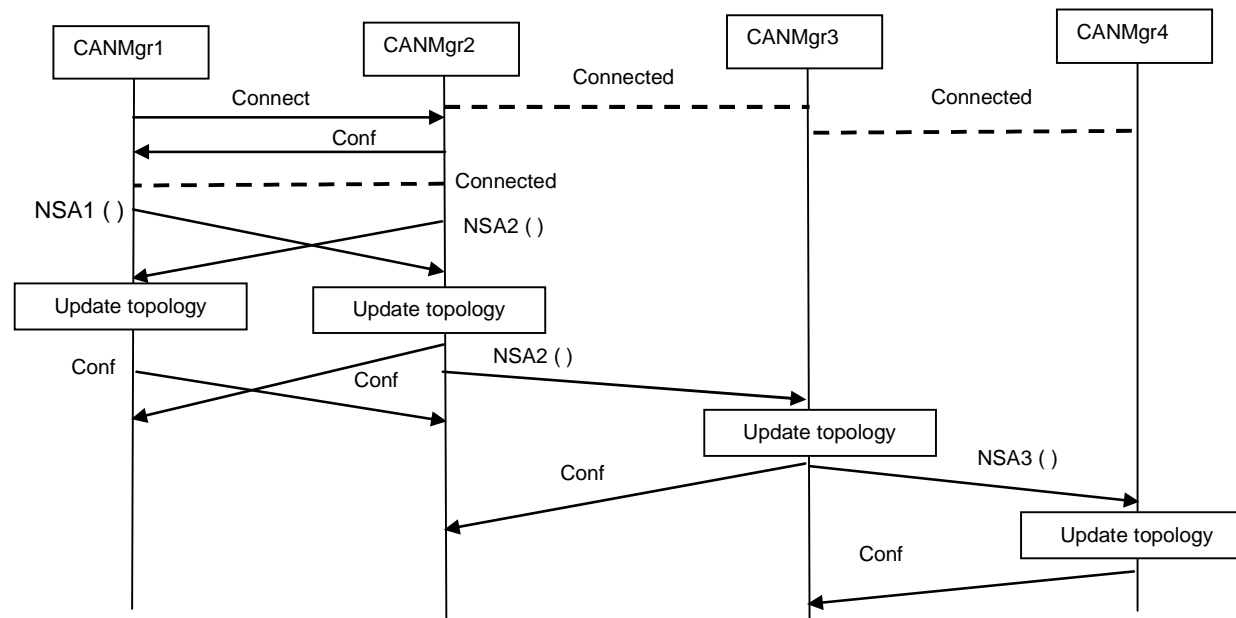
2. TNRDP (cont'd)

Messages

- *Connect* – connection between two CANMgrs neighbors
- *Disconnect* – disconnect to a neighbor
- *NSA* – broadcast to all neighbors to update local graphs
- *Confirmation* – confirmation of “active messages”
- *Error* – signals syntax or semantic errors
- *Hello* – keep-alive connection
- Message format:
 - *Type, Seq_no, Src_Mgr-Id, Dest_Mgr_Id, Data_length, Data*
- Sequence numbers are increased in order by each sender

2. TNRDP (cont'd)

Example- message sequence chart



- Graph: 1 <-> 2 <-> 3 <-> 4
- Connections: 2-3, 3-4
- 1 wants to join and sends a connect to 2



2. TNRDP (cont'd)

Implementation and preliminary performance evaluation

- The protocol was implemented in Java for simulation and evaluation
- Communication complexity for a linear network
 - $O(D^2)$, D is the number of domains
- Communication complexity for a network of random topology
 - $O(D*n*d)$, D number of domains, d diameter of network in domains/hops, n number of connections for each domain



3. Conclusions

- A proactive **Topology and Network Resources Discovery Protocol** has been specified and designed and implemented
 - To be used between domain managers in order to support creation of multi-domain Virtual Content Aware Networks
 - Scalable solution
- This is a **Software Defined Networking-** oriented solution
 - CAN Managers can be replaced by SDN Controllers
 - Separation between the Data and Control Plane
 - Partially centralized management
- Possible future development: migration towards full SDN approach
 - Develop/use a Network Operating System
 - Replace the vertical protocols controlling routers with OpenFlow



- Thank you!
- Questions?

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