TIM FutureNet
A CORD based network demonstrator

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Summary

- Intro and motivation
- Architecture of network demonstrator
- Optical transport network implementation
- Enterprise service implementation
- TIM’s experience feedbacks
- Conclusions
TIM FutureNet: a CORD inspired initiative towards 5G

• Building-up on planned/under discussion short term evolutions and bringing the network into a step further – a 5G-enabled infrastructure -, by borrowing the technologies and practices from the data center industry

• Aims to exploring the applicability of new technologies, software-defined control and management, virtualization, open source software and disaggregation, going beyond the early introduction today struggling with relative maturity and limited architectural consistency

• The FutureNet vision builds on the CORD technical approach, applying a blue sky approach to the design of Central Offices and PoPs

• In order to exploit the potential of the CORD approach and value proposition in production deployments, some issues still need to be sorted out
TIM FutureNet: What is really new?

• **All COs become Data Centers**: from access/aggregation to metro/edge PoPs, not only big core PoPs

• **Disaggregation** and **white box** approaches: no dedicated hardware in central office, neither for transport nor for optical. Virtualized control plane on general purpose servers, IP data plane on white box switches, optical data plane on disaggregated hardware (optical interfaces, ROADM, OLT,...) managed by SDN controllers. The geographical transport network becomes a data center interconnection network

• Mainly **open source** software to realize network functions

• Open platform for the integration of external elements
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TIM FutureNet – Node architecture

A CORD based architecture

White box switches to perform packet switching and high speed packet functions

Transport and access network elements are completely disaggregated

Compute and storage commodity hosting control plane and virtual network functions

Same architecture for all network nodes with growing size and complexity
TIM FutureNet: Network Architecture

Access/Aggregation PoP
- SDN Controller
- VIM
- VNFM

OLT
- COMPUTE & STORAGE

TERAROUTER
- SDN Controller
- VIM
- VNFM

Enterprise
- Access/Aggregation Areas
- Metro Transport Network
- Core Transport Network
- Edge PoPs

Mobile
- RRU

Residential
- Edge PoPs

End-to-End Service Orchestrator
- Network Orchestrator
- NFV Orchestrator
- T-SDN Controller

Edge PoP
TIM FutureNet - Today’s Network

TIM FutureNet - A CORD based network demonstrator
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TIM FutureNet - Today's Network

Node FutureNet 1 (R-CORD 4.0)
- Release: R-CORD 4.0
- Services: Fixed access
- SDN Controllers: ONOS-CORD, ONOS-Fabric
- Fabric SW: 3 Accion 5712
- Servers: 2
- OLT: Y
- RAN: N
- OADM: Y, Filterless
- Transponders: Y
- OLS: Y

Node FutureNet 2 (R-CORD 2.0)
- Release: R-CORD 2.0
- Services: Fixed access
- SDN Controllers: ONOS-CORD, ONOS-Fabric
- Fabric SW: 4 Accion 5712
- Servers: 2
- OLT: Y
- RAN: N
- OADM: Y, Flexible
- Transponders: Y
- OLS: Y

Node FutureNet 3 (M-CORD)
- Release: M-CORD
- Services: Mobile access
- SDN Controllers: ONOS-CORD, ONOS-Fabric
- Fabric SW: 1
- Servers: 3
- OLT: N
- RAN: Y
- OADM: N
- Transponders: N
- OLS: N

Node FutureNet 4 (R-CORD)
- Release: R-CORD 2.0
- Services: Mobile access
- SDN Controllers: ONOS-CORD, ONOS-Fabric
- Fabric SW: 1 Accion 5712
- Servers: 3
- OLT: Y
- RAN: N
- OADM: N
- Transponders: N
- OLS: N

Node FutureNet 0 (Transport only)
- Release: Transport only
- Services: IP&Optical transport
- SDN Controllers: ONOS-Fabric
- Fabric SW: OVS, SR-IOV
- Servers: 2
- OLT: N
- RAN: N
- OADM: Y, Flexible
- Transponders: Y
- OLS: Y

Node FutureNet 1 (R-CORD 4.0)
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- Fabric SW: 3 Accion 5712
- Servers: 2
- OLT: Y
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Node FutureNet 2 (R-CORD 2.0)
- Release: R-CORD 2.0
- Services: Fixed access
- SDN Controllers: ONOS-CORD, ONOS-Fabric
- Fabric SW: 4 Accion 5712
- Servers: 2
- OLT: Y
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- Release: M-CORD
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- SDN Controllers: ONOS-CORD, ONOS-Fabric
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Fixed access innovation in FutureNet

We are working with some traditional and innovative vendors to integrate their ONOS driven OLT prototypes in FutureNet

• Collaboration with traditional vendors should allow TIM to follow and possibly influence their SDN roadmaps even if not tailored to the CORD paradigm
• Collaboration with innovative vendors involved directly in the CORD project allows TIM to explore the whole potential of the new approach both in terms of new CO architecture and OLT disaggregation

• Objective: integrate the solutions of partner vendors in our FutureNet nodes. According to their contraints and requirements the best way of has to be found
• We are asking vendors to use preferably vOLT-HA as abstraction layer and producing YANG data models of their devices to be able to manage them by means of NETCONF
• Contributing also to the work of the recently initiated Broadbad Access Abstraction project
M-CORD – TIM evaluation of vRAN and vEPC based on CORD and Radisys

- **Objective:** to build a complete solution that includes all the components of a new generation mobile network (vRAN, VBBU and VEPC) placed in a Data Center at the edge of the network in fully virtualized mode

- **Architecture:** It is based on the CORD components or OpenStack as VIM, ONOS as controller SDN and XOS as local orchestrator of the individual components. Dedicated infrastructure created by Radisys with VRAN and vEPC

- **Test objective:** Evaluate the functionality and performance limits of a highly-pushed virtualized solution. Evaluation Object Features: CPUP separation, VBBU, slicing, functionality disaggregation, IoT optimization
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TIM FutureNet - Transport Network implementation

FutureNet0
Reconfigurable OADM

FutureNet1
Filterless OADM

MUXPONDER

FutureNet2

FutureNet3

FutureNet4
TIM FutureNet - Disaggregated Optical Transport Node

- LEAF SWITCH
- MUXPONDER
  - 1-10 COLORED GBE (PLUGGABLE)
- A/D
  - SINGLE DEVICE
    - 4 DEGREES ROADM
  - 100/200G DEG 1, DEG 2, DEG 3
- AWG
- ROADM
- SPLITTER
- LINE SYSTEM
- OPTICAL TRANSPORT NETWORK
- 10GBE
- 10GBE
- 10GBE
- 4X10G
- SPLITTER
- 1-10 COLORED GBE (PLUGGABLE)
TIM FutureNet - Disaggregated Optical Transport Node

Pluggable 1-10GE SFP on fabric leaf switch

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TIM FutureNet - Disaggregated Optical Transport Node

Coriant Groove G30

- Supports up to four field replaceable, individually configurable and hot-swappable 400G sleds (or field replaceable units).
- Each 400G sled can be equipped with up to two 200G line side interfaces (CFP2-ACO) and a mix of 10G, 40G, and 100G client interfaces.
- Each of the eight line side ports can be independently configured as either 100G DP-QPSK, 150G DP-8QAM, or 200G DP-16QAM.
- Standards-based interfaces including support for open Northbound Interfaces (NBIs) and APIs: CLI, SNMP Fault Management, YANG model based NETCONF and RESTCONF APIs.
Line System: presently based on commercial equipment and not managed by SDN controller
TIM FutureNet - Disaggregated Optical Transport Node

Four degree ROADM

LEAF SWITCH

10GBE
10GBE
10GBE

MUXPONDER

4X10G

100/200G

SPLITTER

ROADM

SINGLE DEVICE
4 DEGREES
ROADM

A/D

DEG 1

DEG 2

DEG 3

AWG

ILA

10GBE
10GBE
10GBE

1-10 COLORED GBE
(PLUGGABLE)

1-10 COLORED GBE
(PLUGGABLE)

MUXPONDER

PLUGGABLE
XPONDER

ROADM

LINE SYSTEM

LINE SYSTEM

LINE SYSTEM

CLIENT

OPTICAL TRANSPORT NETWORK

100/200G Line terminal
TIM FutureNet - Disaggregated Optical Transport Node

Based on Lumentum TrueFlex
Twin 1x20 WSS + evaluation board
TIM FutureNet - Disaggregated Optical Transport Node

Four degree ROADM – OpenFlow Agent

- Running on Linux (tested on Ubuntu 14.04 and Fedora Core 3)
- OpenFlow 1.3 + Optical Transport Protocol Extensions (ONF TS-022)
- Implementation covers optical features (e.g. match, instructions, ...) only
- ROADM is controlled by sending appropriate commands to the WSS evaluation board through a RS-232 interface.
- Maintains status for installed flows, ROADM ports, OpenFlow sessions with (eventually) multiple controllers.
TIM FutureNet - ONOS Transport SDN Controller
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TIM FutureNet - E-CORD short term implementation

Point-to-point Carrier Ethernet Service

Orchestration: XoS + ONOS

Transport SDN Controller

Metro Transport Network

Node FutureNet 0 (simplified Edge structure)

Node FutureNet 2 (R-CORD 2.0)

Node FutureNet 3 (M-CORD)

Node FutureNet 4 (R-CORD 2.0)

Node FutureNet 1 (R-CORD 4.0)

Transport SDN Controller

SDN Controller

VIM

VNFM

SWITCH

TRANSPORT

OLT

Internet

Residential

Enterprise

Carrier Ethernet Service

Disaggregated OLT
TIM FutureNet - E-CORD short term implementation

Point-to-point Carrier Ethernet Service

- The implementation will be based on the upcoming E-CORD release
- To the reference implementation of the release, we add the optical transport network control

Data-plane:
- Programmable CPE ea1000 Microsemi
- Central Office fabric Accton 5712 EdgeCore
- Transport Network Openflow-enabled ROADM

![Diagram showing network components and connectivity](image-url)
Possible use case for CORD / ONAP Interworking

**MSO** - *Master SO* provides ONAP service orchestration, implemented via BPMN flows operating on Models distributed from SDC.

**SDC** - *Service Design & Creation* provides visual design & testing tools, templates and catalogs to model and create resources, and services.

**XOS/ONOS**

**Access Node**

**Transport NW**

**Access Node**

**Communication Bus & API**

**Design Time**

**Runtime**
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TIM’s experience feedbacks
A Service Provider perspective

Problem #1: installation behind a proxy server

• Many Telcos’ lab facilities are closed environments that can access the Internet only through proxy servers

• The installation of CORD software behind a proxy is “not straightforward”: it requires a lot of additional work with a trial and error approach that is heavily time consuming

• An experimental guide for installing CORD behind a proxy was originally released for CORD 1.0 but it was incomplete. Recently it has been updated but it focuses only on CORD-in-a-Box installation
TIM’s experience feedbacks
A Service Provider perspective

Problem #2: software predictability

• The CORD installation process leverages live updates of most software packages, libraries, etc.

• This approach can lead to failures when newer versions of some software components have become incompatible with other components.

• We experienced this problem twice with CORD 2.0:
  • The new version of the networking-onos plugin for Neutron is not compatible with the Kilo release of Openstack used in CORD 2.0
  • A problem with release '1.21.1' of Python urllib3 was causing a malfunction in Nova

• Moreover, live updates in general lead to systems (servers/VMs/containers) that are slightly different from the others, potentially rising configuration bugs that are difficult to diagnose
TIM’s experience feedbacks
A Service Provider perspective

Request for a solution

• We think that a self-contained installation package or repository, with all software needed in the right version, would prevent the problems described in the previous slides and it would guarantee:
  • fast and successful installations without needing to access the Internet
  • predictable systems with (almost) identical and stable configurations

• But maybe alternative solutions exist
Conclusions

- TIM is developing the FutureNet network demonstrator to evaluate the evolution of central offices towards a data center based architecture
- Virtualization, disaggregation, open source software, openness to external elements are key elements for this evolution
- Integration with other initiatives (e.g. ONAP) is fundamental
- The current CORD implementation is not mature for a real field deployment, many features have to be introduced but the improvements seen in the last year is promising and could lead to a stable, manageable and measurable implementation in a reasonable time frame
Thank you