ONOS Intent Monitor and Reroute service: enabling plug&play routing logic

Davide Sanvito, Daniele Moro*, Mattia Gullì*, Antonio Capone*, Ilario Filippini*, Andrea Campanella^*

* Dipartimento di Elettronica, Informazione e Bioingegneria, Politecnico di Milano

^ Open Networking Foundation

IEEE Conference on Network Softwarization (NetSoft) 2018

27/06/2018

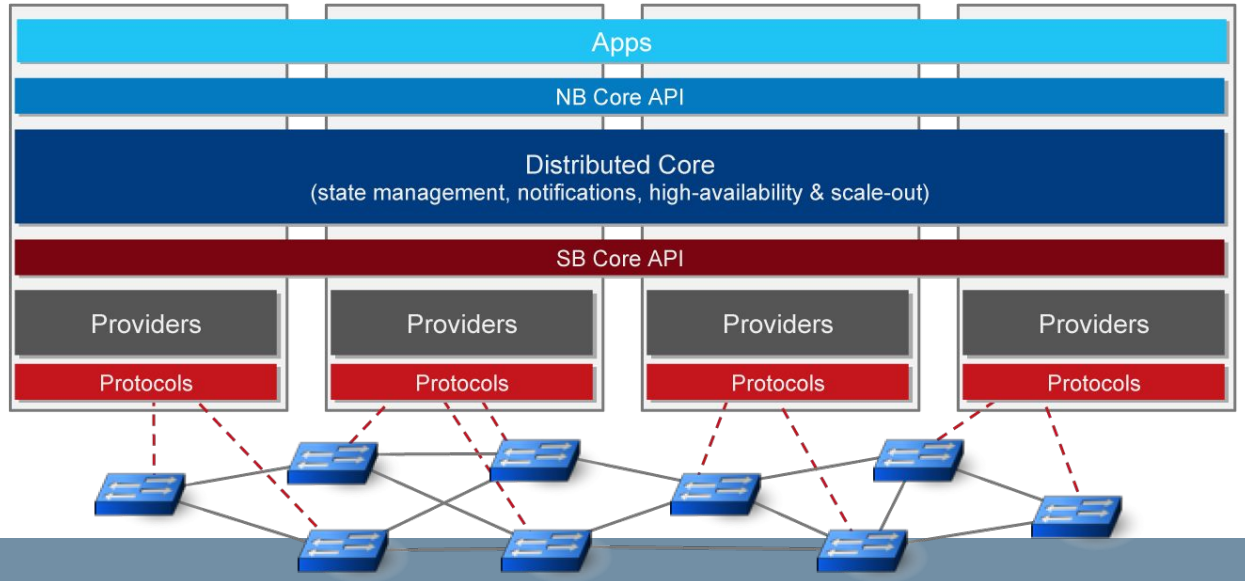
Open Networking Foundation

Intent-Based Networking

- High level network policies (***intentions***):
  - give connectivity between node A and node B
  - consider only HTTP traffic
  - reserve 100 Mbps bandwidth on the path
- Network complexity abstraction
- Intent submitted through North-Bound Interface (NBI) offered by SDN controller
  - *OpenDayLight*: Network Intent Composition interface
  - ***ONOS***: Intent Framework
- Intent compilation hidden inside SDN controller
  - from high level ***intentions*** to low level ***flow rules***

Open Network Operating System (ONOS)

- SDN Network Operating System built for Service Provider networks
- Intent Framework (in charge of intent compilation):
  - **extensible** (new intent and new compiler can be added)
  - **recompilation** in case of network failures
  - each intent is **individually** compiled
  - only **shortest path** logic for intent is available

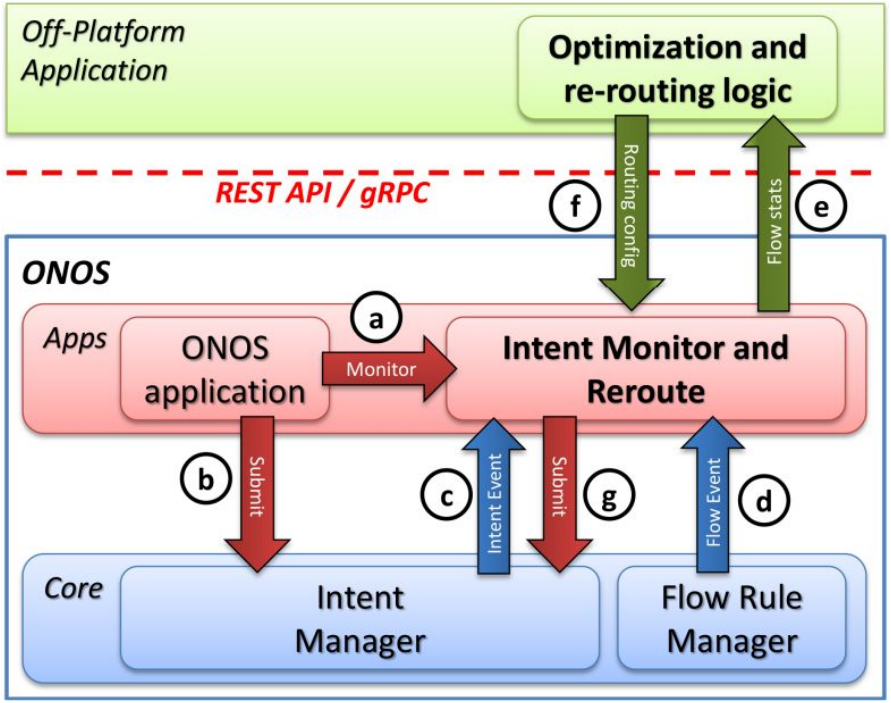


Our objective

1. **Re-optimize the path** according to topology state and flow level statistics
2. **Different routing logic** other than shortest path
3. **Joint compilation** of multiple intents to consider a global network objective (e.g., minimizing Maximum Link Utilization - MLU -)
4. **No impact** on ONOS high performance (external routing logic)

Intent Monitor and Reroute Service

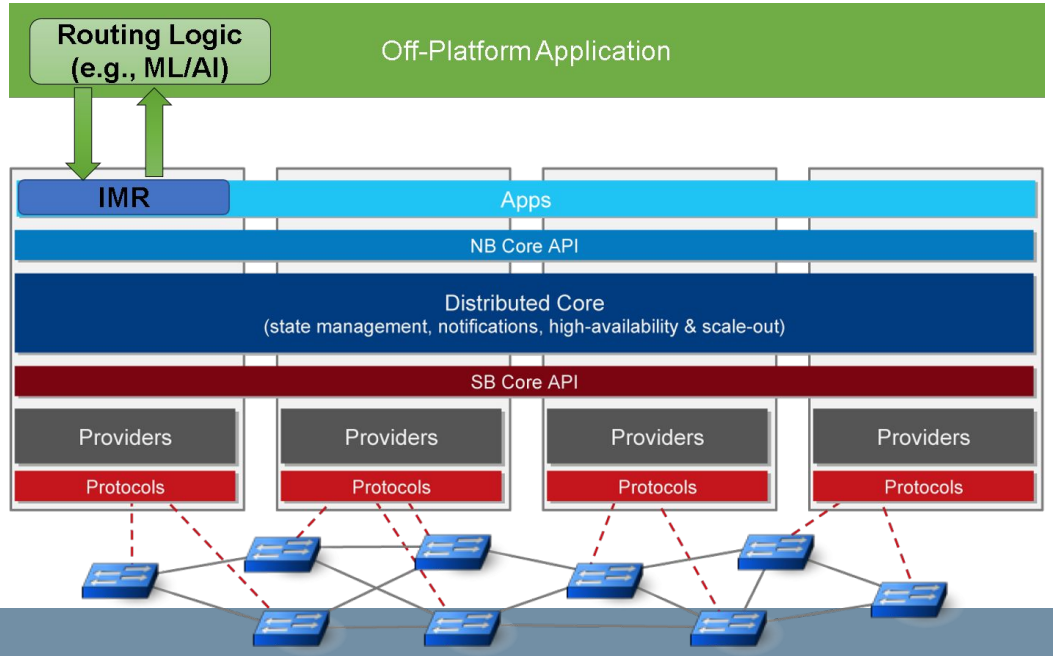
- IMR exposes statistics as a traffic matrix based on the intent to an Off-Platform Application (OPA)
  - Internally it keeps track of the *Intent <-> FlowRule* mapping
- OPAs can re-route an intent through IMR API specifying for each intent a specific path
- IMR gets intent statistics and intent re-compilation event from the Intent Manager



ONOS Integration

IMR enables:

- Decoupling of routing logic from application
- Plugging of external Traffic Engineering Schemes (e.g. ML/AI algorithms)
- Joint external re-compilation of multiple intents

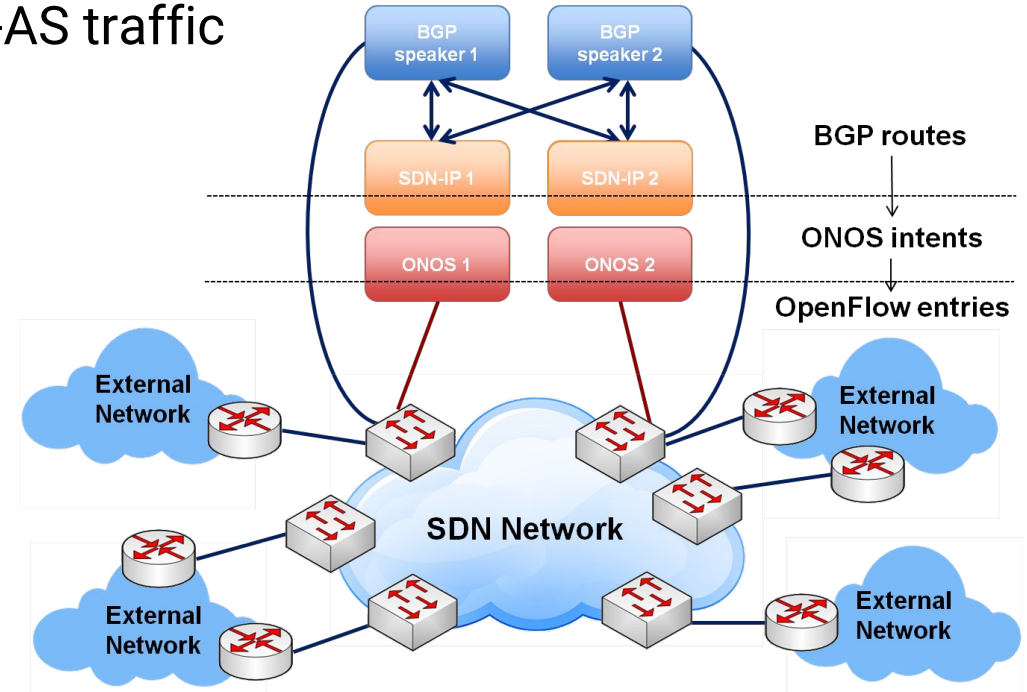


IMR APIs (CLI/REST)

- ONOS applications or users can require the monitoring and re-routing of intents
- CLI APIs
  - `imr:startmon appID appName [intentKey]`
  - `imt:stopmon appID appName [intentKey]`
- REST APIs: external applications (OPAs) can retrieve statistics and require re-routing
  - GET /intentStats*[/appID/appName/intentKey]*
  - POST /reRouteIntents
  - GET /monitoredIntents*[/appID/appName/intentKey]*

SDN-IP application

- ONOS application which enables SDN network to connect to legacy IP networks using Border Gateway Protocol (BGP) while appearing externally as a traditional Autonomous System (AS)
- both BGP peering and AS-to-AS traffic managed through intents
- Extended SDN-IP:
  all the transit traffic intents are monitored via IMR



Off-Platform Application Routing Logic

- OPA logic is independent from the application
  - collect TMs from ONOS via IMR's REST API
  - apply the CRR (or the selected routing logic)
  - schedules the activation of the routing
  - applies the routing via IMR's REST API

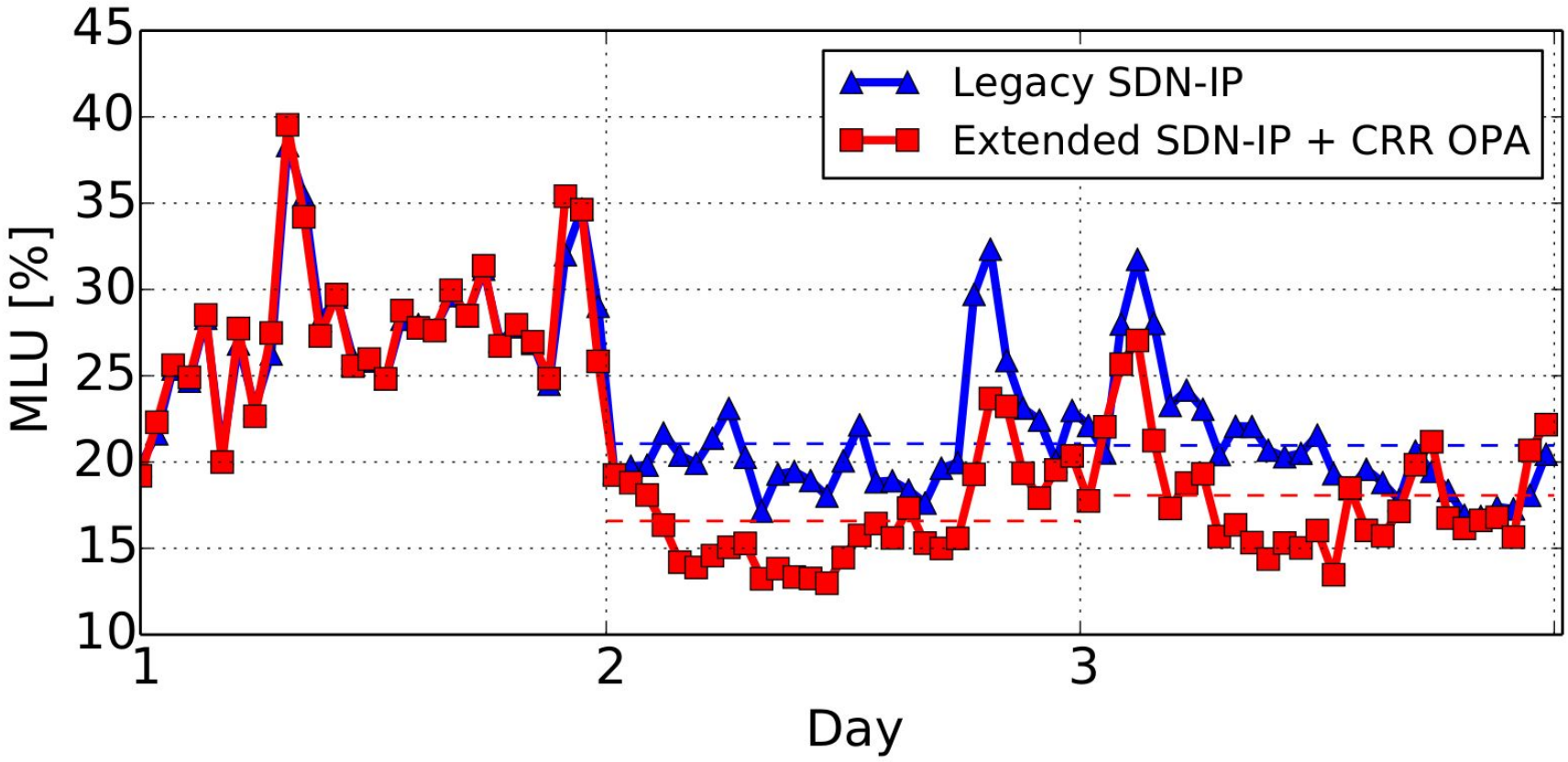
- Clustered Robust Routing (CRR) [1]
  - computes a set of robust routing configurations with a guaranteed minimum holding time
  - tunable trade off between completely dynamic and completely stable routing

[1] D. Sanvito, I. Filippini, A. Capone, S. Paris & J. Leguay. "Adaptive Robust Traffic Engineering in Software Defined Networks." IFIP Networking 2018

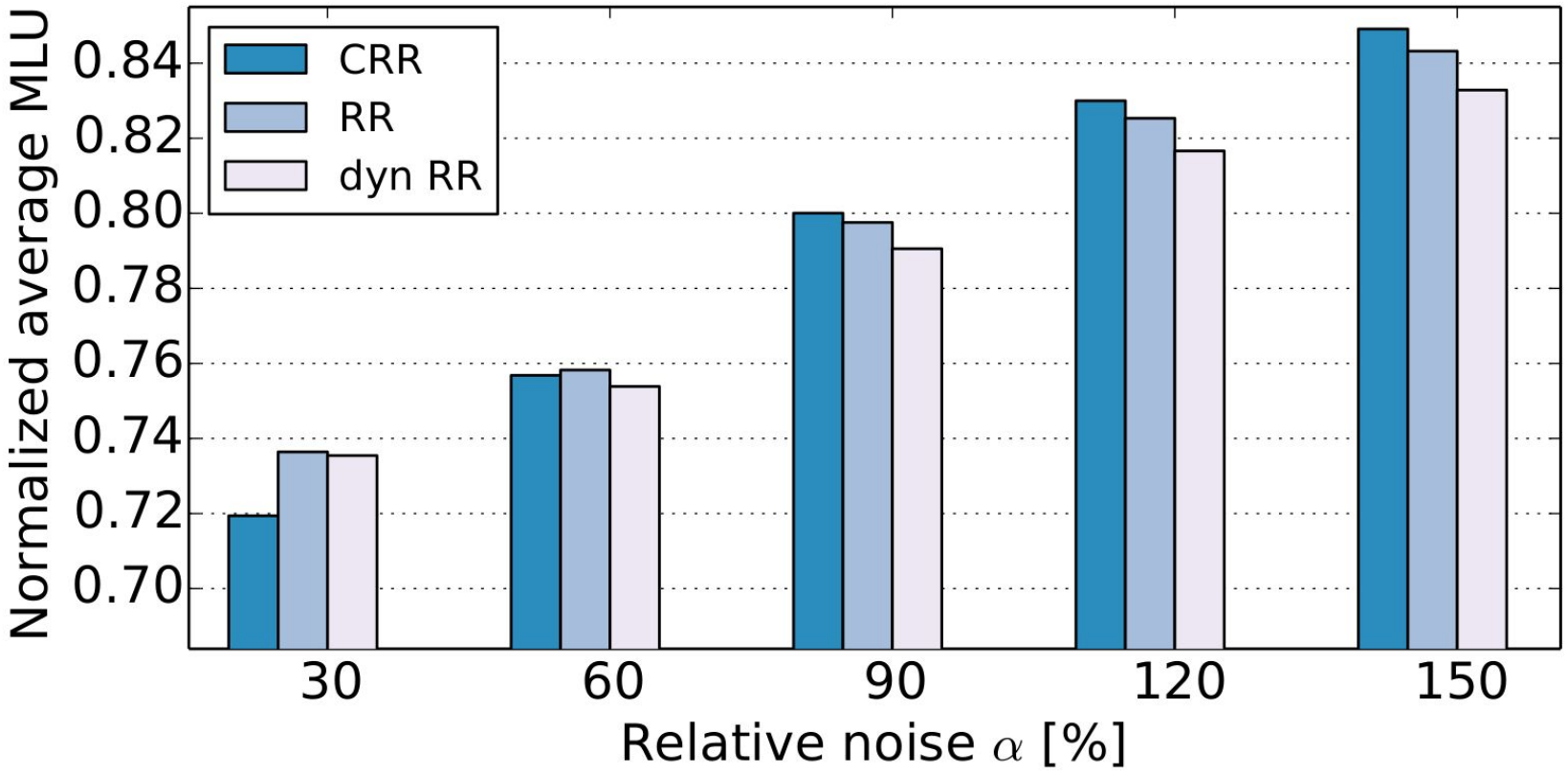
Tests

- SDN-IP modified version (IMR integration)
- OPA + CRR application
- Emulation of Abilene backbone topology (using *Mininet*)
- Replay a subset of 3-days Traffic Matrices using *iperf* (we played 5 minutes of Abilene TM every 15 seconds)

Results


45
40
35
30
25
20
15
10
MLU [%]
1
2
3
Day
Legacy SDN-IP
Extended SDN-IP + CRR OPA

Results - Dynamic



Conclusions

IMR can improve network performances:

- decoupling routing logic from application
- integrating external routing logic
- providing per-intent statistics
- jointly (re)compiling multiple intents

Future Works

- gRPC support
- Multi path routing (ECMP)
- Monitoring of additional type of ONOS intents (now only Point To Point and Link Collection Intents are supported)

Open Source Contribution

- IMR integrated in ONOS 1.13.0 Nightingale
- Documentation
  https://wiki.onosproject.org/x/hoQgAQ
- Demo
  Intent FWD app + external greedy routing alg
  https://youtu.be/hSO4pch1eAg

Thanks!

Questions?

daniele.moro@polimi.it