Providing Infrastructure Functions for Virtual Networks by Applying Node Plug-in Architecture

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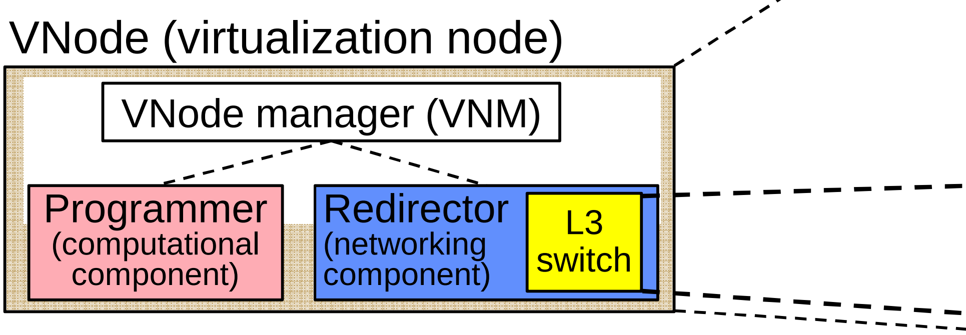
Summary: A method for providing functions of VNode infrastructure switches, such as switching or routing, to slices is proposed. The plug-in interfaces and the interfaces for providing layer-3/VLAN switch functions to slices were designed, implemented, and evaluated.

1. Introduction

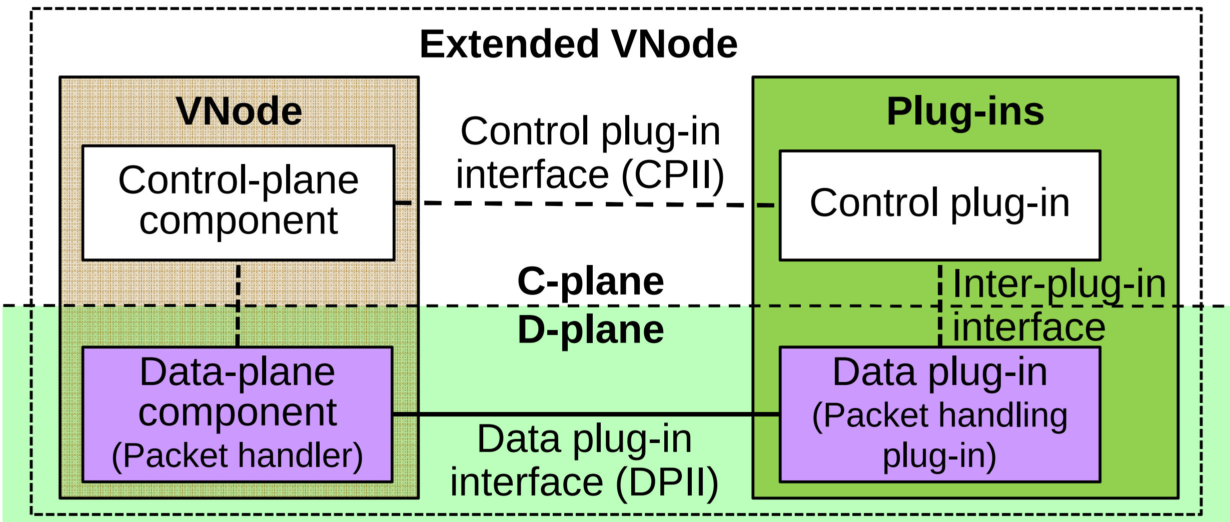
Background: A component of VNode (i.e., redirector) contains an L3 switch, but slices could not use its functions, such as switching or routing.



Proposal: A method for supporting L3 switch functions by extending the VNode plug-in architecture [1, 2] is proposed [3].

2. Outline of plug-in architecture

- New types of virtual nodes and links can be added to VNode.
- New types are implemented by a combination of two types of plug-ins:
  - *Data plug-ins* extend data-plane functions such as packet forwarding.
  - *Control plug-ins* extend control-plane functions: manages data plug-ins.
- New types can be specified in a slice definition (RSpecs).
  - All the implementation parameters can be specified by the developer, or
  - The implementation parameters can be hidden from the developer (can be supplied by control/management components of the VNode).



3. Application of plug-in architecture

The interfaces and the control-plug-in are extended or newly designed.

- **Data plug-in**: the L3 switch — the same switch as the data-plane component of the redirector, but they must be isolated.
- **Control plug-in**: The control software must be newly developed.
- **Data-plane interface** (**DPII**) is extended: Original DPII is MAC-address-base, but new DPII is VLAN-based — L3-switch requirements.

(a) VLAN-ID-based DPII

SDMAC	SSMAC	SEType	VLAN ID etc.	Payload

(b) MAC-address-based DPII

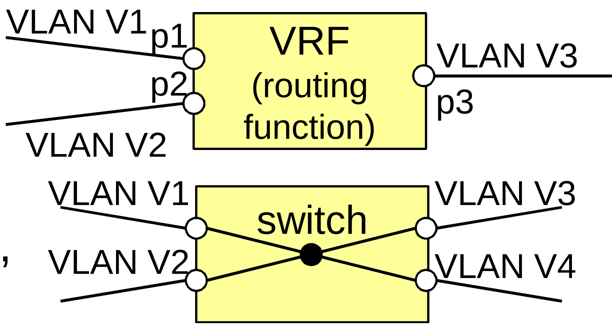
PDMAC	PSMAC	PEType	SDMAC	SSMAC	SEType	Payload

- Inter-plug-in interface: CLI of the L3 switch may be used.

4. L3 switch functions to be provided to slices

L3 switch functions are provided by new node types.

- **Routing function** (VRF function) is supported by “virtual_router” type.
- **Switching function** (of Ethernet) is supported by “virtual_switch” type.



Implementation parameters can be specified, or can be hidden from the developer.

Example: Slice definitions (a) w/o implementation parameters

```
<nodeSliver name="vrf1" …>
  <instance type="virtual_router">
    <params><param key="P1" value="V1" /> …
       <param key="Pn" value="Vn" /></params>
  </instance>
  <vports><vport name="p1"/> … <vport
name="pm"/></vports>
</nodeSliver>
```

(b) with implementation parameters

```
<nodeSliver name="vrf1" …>
 <instance type="extension">
  <params>
   <param key="PlugInName" value="intSw" />
    <!-- Plug-in name -->
   <param key="DataPort" value="vlan" />
    <!-- Specification of data plug-in interface (DPII) -->
   <param key="ControlPort" value="192.168.110.61" />
    <!-- Specification of control plug-in interface (CPII) -->
   <param key="Command-runNodeSliver" value="run_vrf" />
    <!-- Specification of CPI command for configuration -->
   <param key="Command-stopNodeSliver" value="stop_vrf" />
    <!-- Specification of CPI command for de-configuration -->
   <!-- Other paramaters: -->
   <param key="P1" value="V1" /> …
   <param key="Pn" value="Vn" /><!-- Routing parameters -->
  </params>
 </instance>
 <vports><vport name="p1"/> … <vport name="pm"/>
 </vports>
</nodeSliver>
```

5. Prototyping of routing function

- The proposed method was partially implemented in NACE (NC).
  - NACE is a type of VNode, which is used for federations between VNode and ProtoGENI.
- The control plug-in, which communicates with the L3 switch by CLI, was implemented as a program written in Perl.
- OSPF-based IP routing and Ethernet switching functions were implemented.

Acknowledgments

Part of the research results is an outcome of the Advanced Network Virtualization Platform Project A funded by NICT. The authors thank Akihiro Nakao from the University of Tokyo, Satoshi Kamiya from NEC, and other members of the VNode Project for their discussions on virtual-switch interfaces.

References

[1] Kanada, Y., “A Node Plug-in Architecture for Evolving Network Virtualization Nodes”, *2013 Software Defined Networks for Future Networks and Services (SDN4FNS)*, November 2013.

[2] Kanada, Y., “A Method for Evolving Networks by Introducing New Virtual Node/link Types using Node Plug-ins”, *IEEE/IFIP SDNMO 2014*, May 2014.

[3] Kanada, Y., “Providing Infrastructure Functions for Virtual Networks by Applying Node Plug-in Architecture”, *SDN NGAS 2014*, August 2014.