Extending Network-virtualization Platforms by using a Specialized Packet Header and Node Plug-ins

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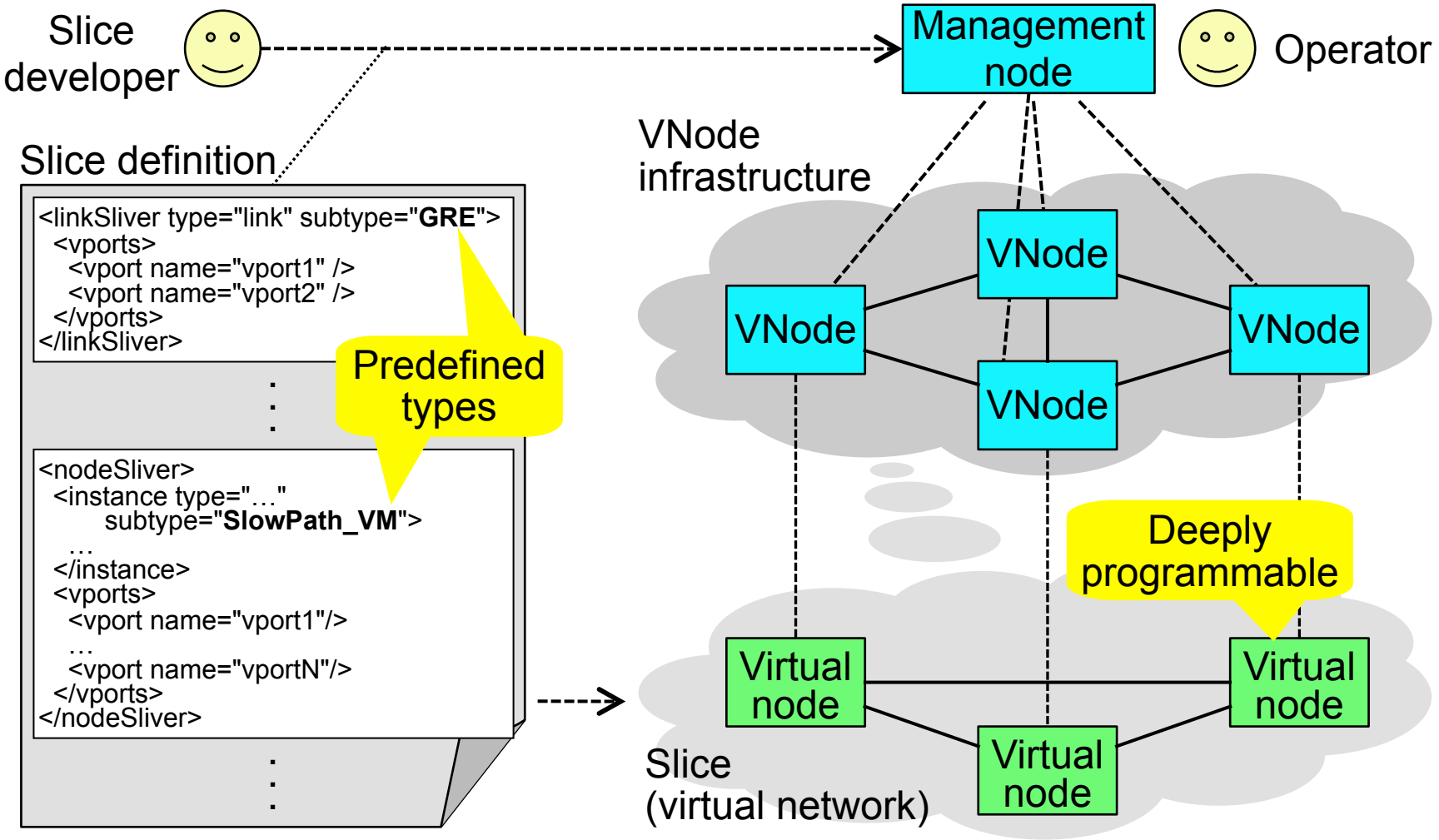
Outline

- **VNode infrastructure is an architecture and testbed for network virtualization.**
  - A VNode means a physical network node (not virtual node).
  - Developers can create slices (i.e., virtual networks) using *predefined virtual-resource types.*
- **A plug-in architecture for VNode, which was proposed in previous papers, enables introducing new types.**
  - Slice developers may require new virtual-resource types.
  - New virtual-resource types can be defined and implemented by using the plug-in architecture.
- **Proposal: A method using plug-in-specific (resource-type-specific) packet headers**
  - This method enables introducing new network-wide functions by new resource-type and plug-ins without modifying slices.

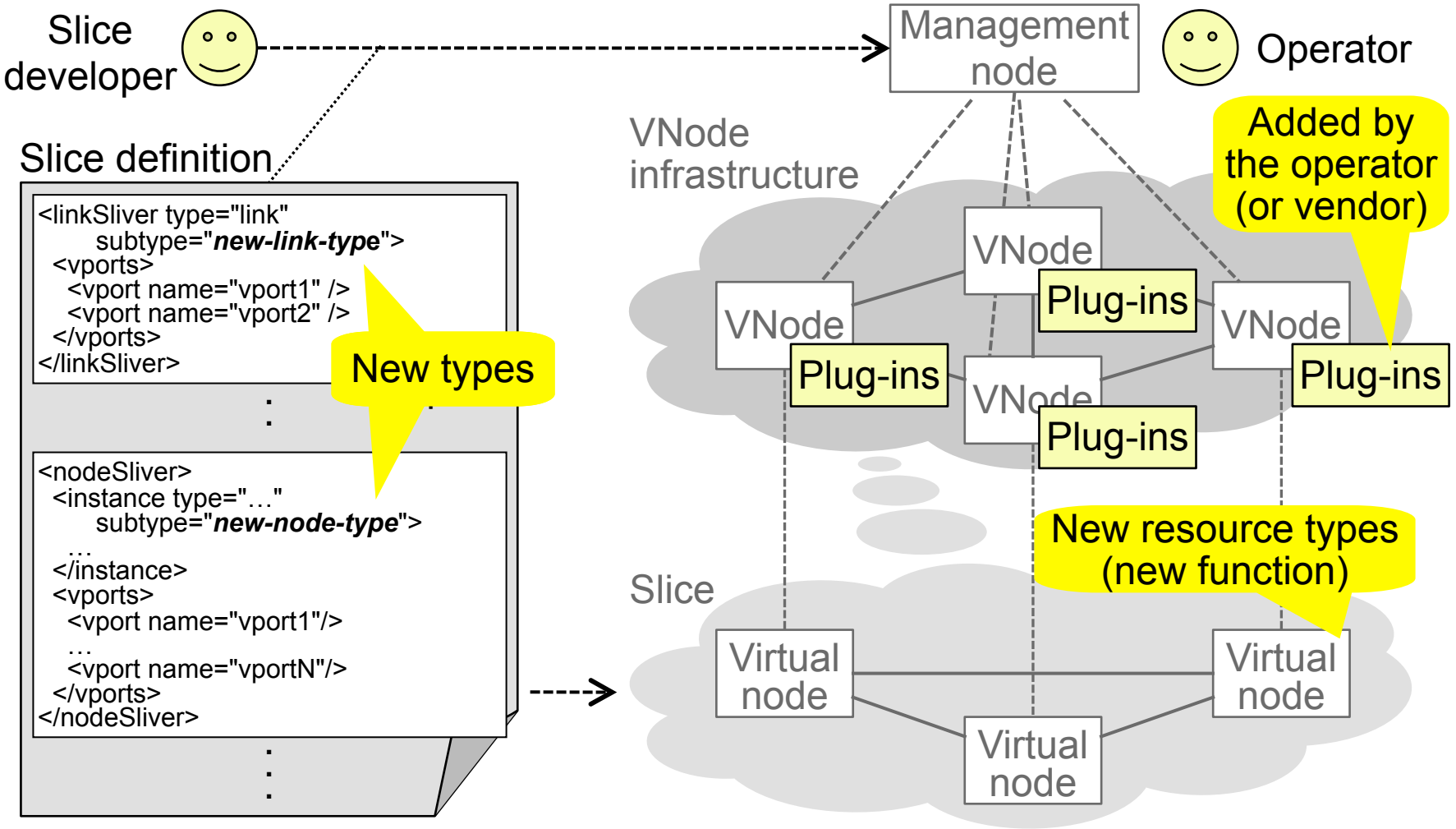
VNode Infrastructure and Slices
(previously proposed)

- **Developers can create slices using *predefined virtual-resource types* (i.e., virtual-node and -link types).**



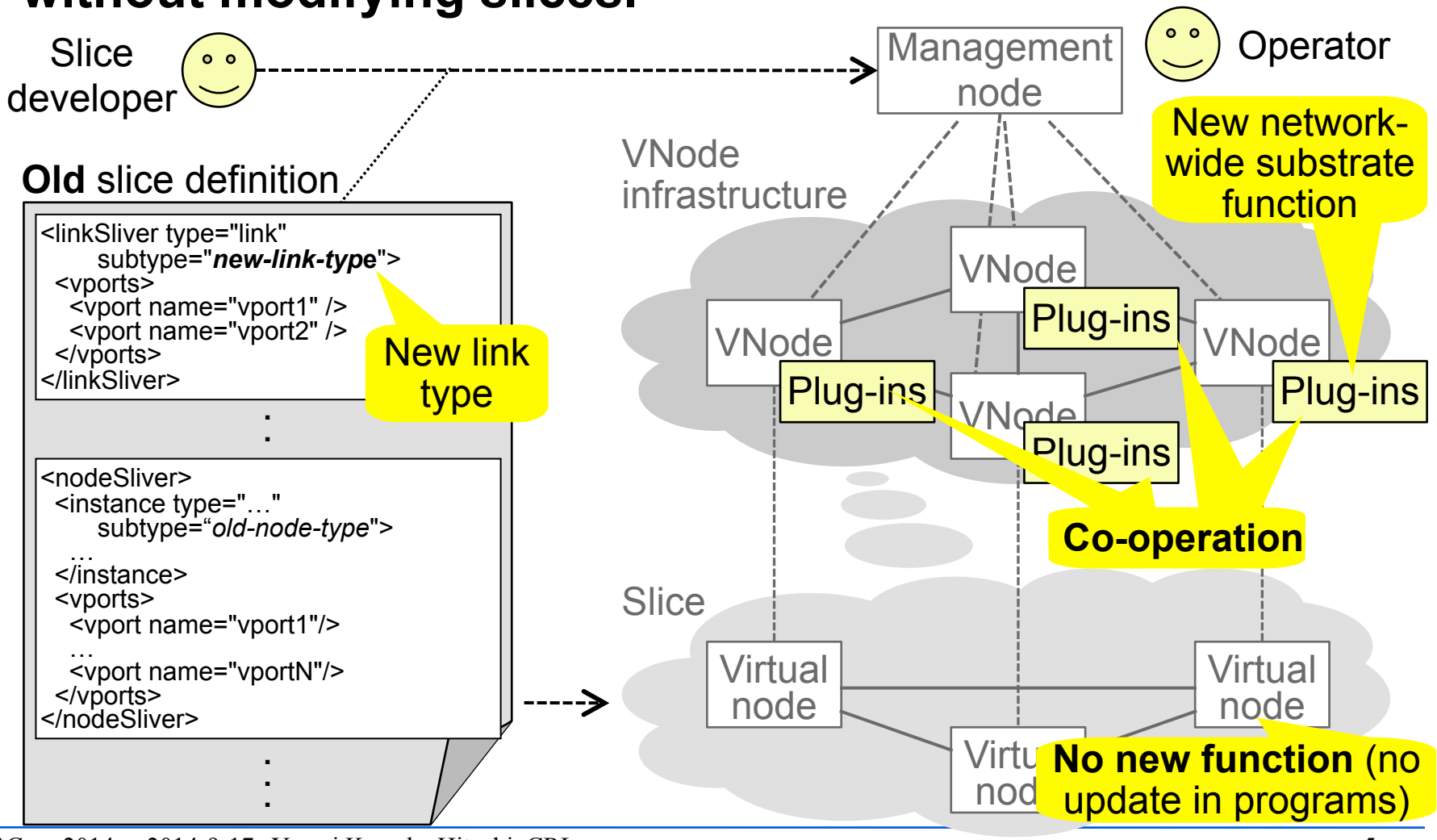
Plug-in Architecture
(previously proposed)

► **New virtual-resource types can be defined and implemented by using the plug-in architecture.**



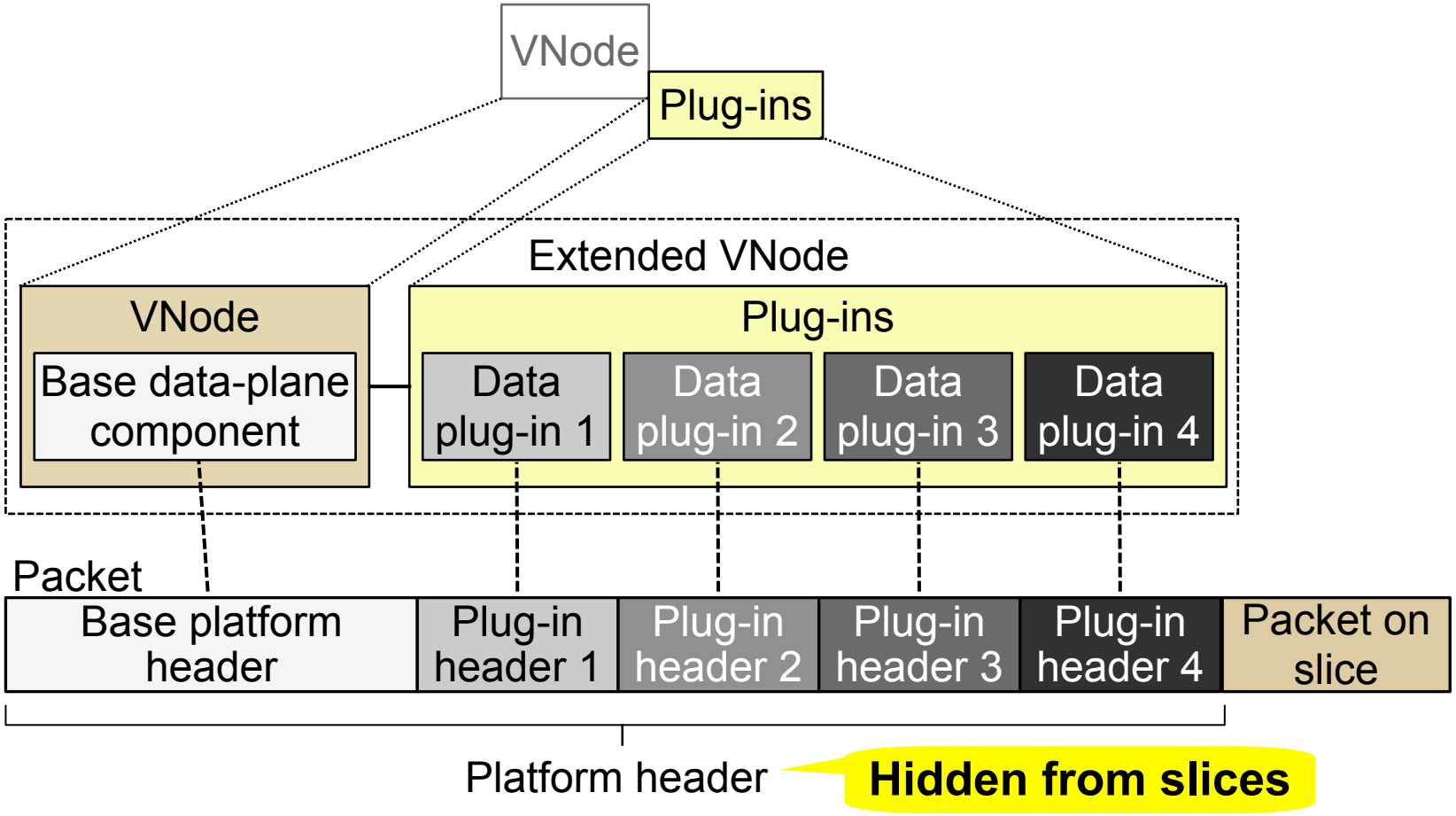
Platform-extension w/o Slice Modification: New Proposal

- **The proposed method enables introducing new network-wide functions by new link-type and plug-ins without modifying slices.**



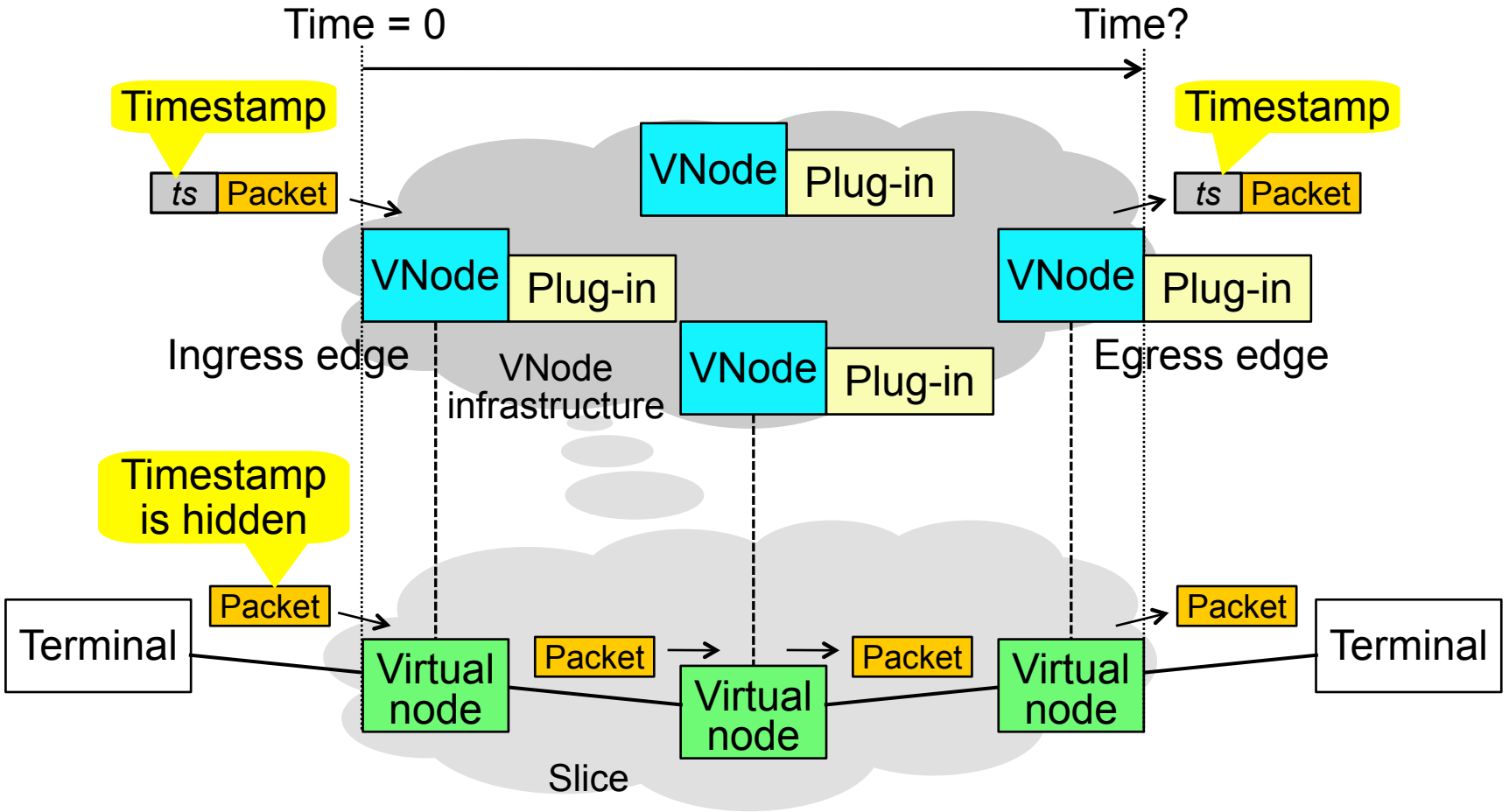
Platform-extension w/o Slice Modification: Method

- New functions and co-operation of plug-ins are introduced by resource-type-specific packet headers.
- Data plane is extended:



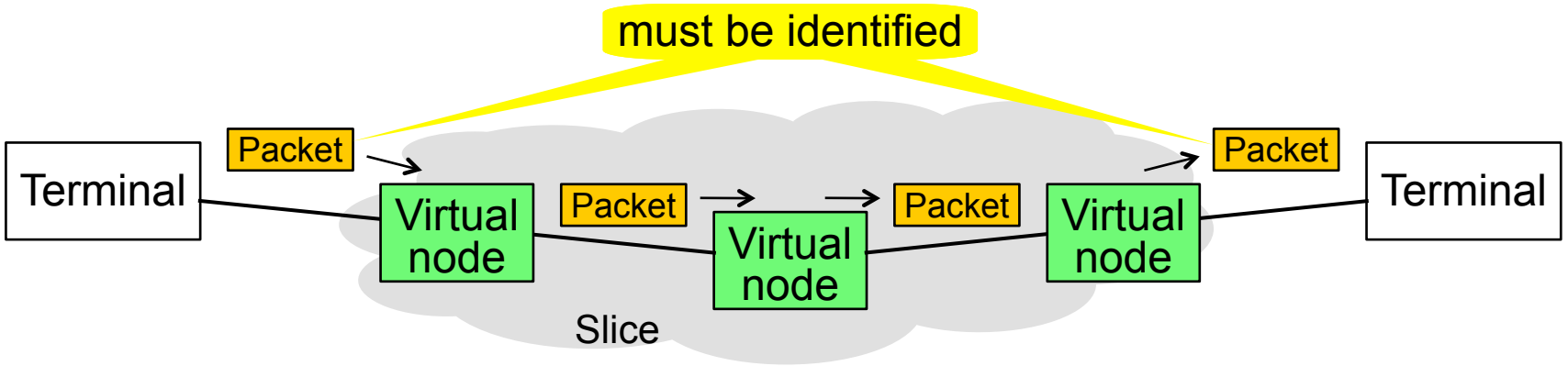
Example of Using Platform-extension: Network-wide Delay Measurement

- **Network-wide delay can be measured without affecting slice design/implementation by using a new link type.**
- **The plug-in header contains a timestamp.**

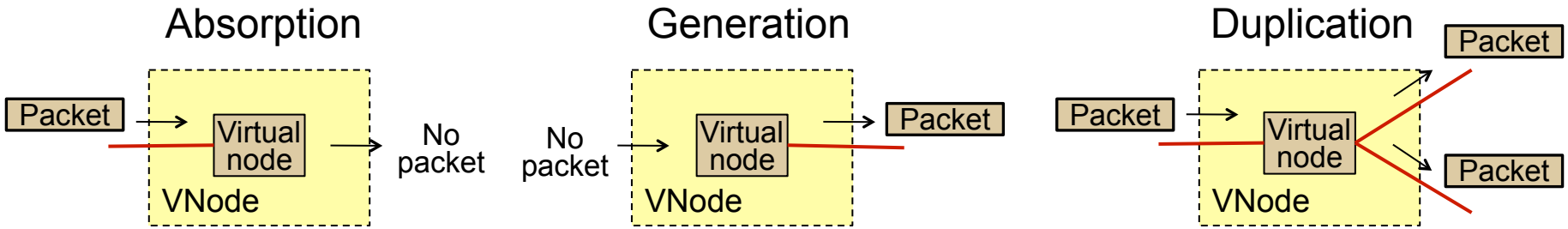


Problem: Packet Identification in Programmable Slices

- **Packets must be identified to track them (i.e., to measure the delay).**



- **Packet identity depends on the node function.**
  - Packets may be absorbed, generated, or duplicated by the node program.



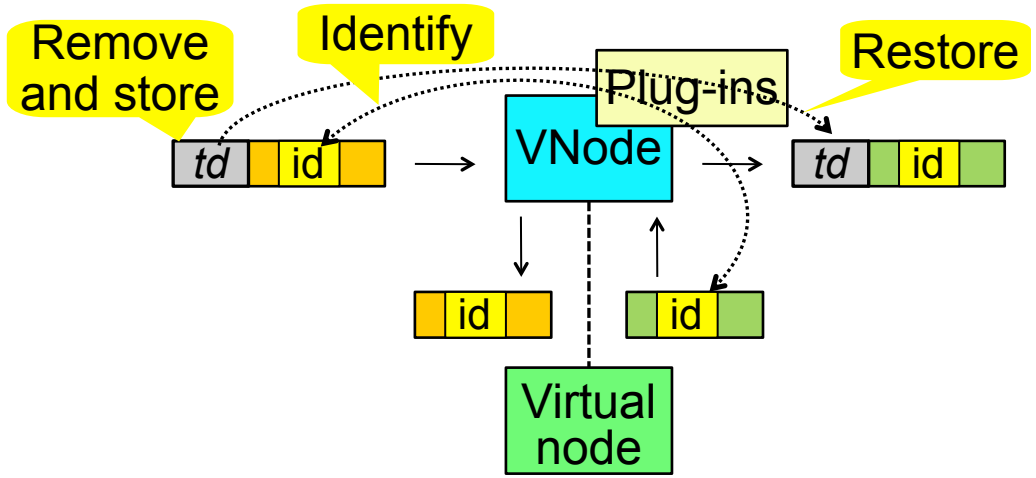
Solution: Slice Supplies Packet Id to Plug-ins

- **The slice (developer) must define the identity of packets.**
  - Simple identity: to specify identifier field.

  - Generic identity: to specify identity function.

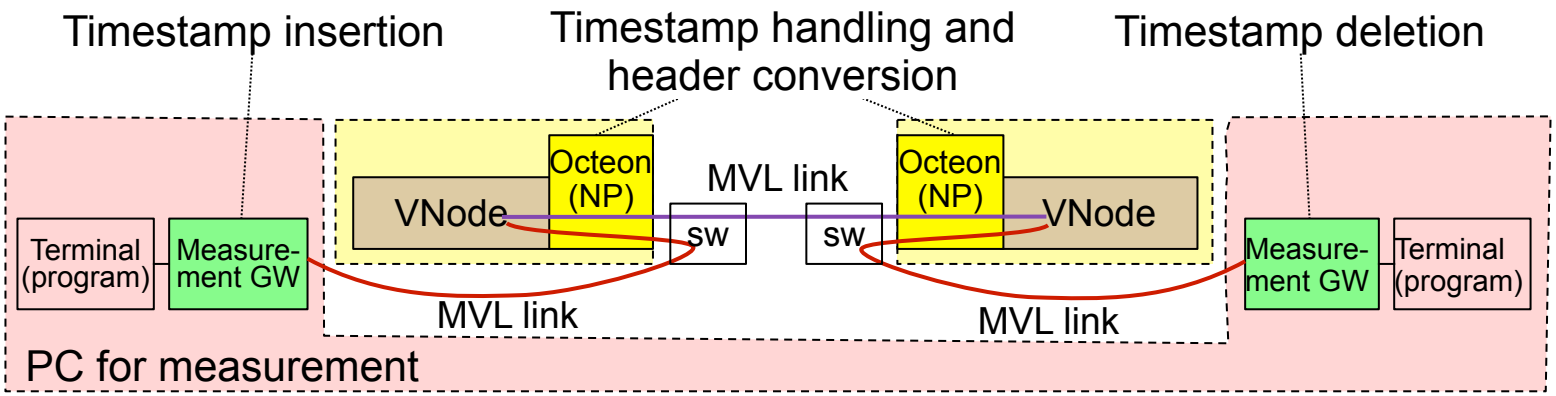
id = *f*(*p*)

- **The plug-in identifies packets.**
  - It removes and stores a platform header from a packet and restores it to the packet.



Evaluation: Conditions

- **A VLAN-based link type with delay measurement function (called MVL type) was introduced.**
- **The plug-in for MVL type was implemented by using network processors (NPs).**
  - Cavium Octeon NP with twelve 750-MHz cores was used.
- **The delay between two simulated terminals with two VNodes were measured.**
  - Two terminals were simulated by one PC to avoid synchronization problem.



Evaluation: Results

► Evaluation results

- Delay: 89 μS (σ = 12 μS) / node.
- Timestamp (TS) handling and header conversion (required for virtual-link processing:

Implementation	Throughput (Gbps)*		Program lines
	TS insertion	TS deletion	
NP program (in Phonepl)	10.0†	9.5†	99‡
Xeon program (in C)**	2.3† (4.0††)	2.2† (4.0††)	190‡

***Packet size: 1024 B. ** Promiscuous mode is used. †No packet loss (< 10^{-6})**
†† Packet loss ratio = 10^{-3} ‡Comment-only lines are not counted.

Conclusion

- **A method for introducing new functions without updating slice implementation is proposed.**
  - Resource-type-specific (plug-in-specific) packet headers are used.
  - The packet headers are processed by the plug-in in each VNode.
- **This method was applied to measurements of network edge-to-edge delay.**
  - A hidden timestamp in each packet is used.
  - Timestamps do not affect slices; i.e., slices do not see timestamps.
- **A virtual link with delay-measurement function was evaluated.**
  - The throughput was 10-Gbps (i.e., wire rate).
  - The latency was less than 100 μS.
- **Future work**
  - Implementation of other node/link functions.
  - Handling multiple plug-in-specific headers.