6lo WG

@IETF 111 - online

Native Short Address for Internet Expansion

draft-li-native-short-address-00

https://datatracker.ietf.org/doc/draft-li-native-short-address/

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Motivation

- An ongoing massive expansion of the network edge that is driven by the "Internet of Things" (IoT) technology
- [SIXLOWPAN]/[SIXLO]/[LPWAN] WGs addresses many foundational issues for those type of deployments
- Existing solutions, however, may have some shortcomings:

Technology	Problem(especially in large scale LLN)
6lowpan-DHCPv6	Consume bandwidth and time before node working, by applying for address from centralized server through multiple hops
6lowpan-AutoConfig	Using large address space to reduce confliction, implicating longer address and larger routing table, thus limit scale of network
6lowpan-RH	RPL information causes extra overhead of packet. Routers consumes resource to advertise、store、manage routing table
6lowpan-IPHC	Context based address uncompressing consumes extra computing resource. 6lo-RPL(RFC 8138) avoids uncompressing hop-by-hop, however bring much more complexity in routing.

Simpler and more efficient addressing/routing/encapsulation exist based on but beyond previous work?

Native Short Addresses (NSA)

- Native Short Addresses (NSA) technique would optimize networking of devices within IoT and towards the Internet
- NSA does not depends on neither specific link-layer conventions nor centralized DHCPv6 server
- NSA does not rely on spreading routing messages to establish the routing table
- NSA (context free and route over case)

0	1	0	1	TF	NH	HL	Payload Length (variable Length)	I / o	A M	SA	DA

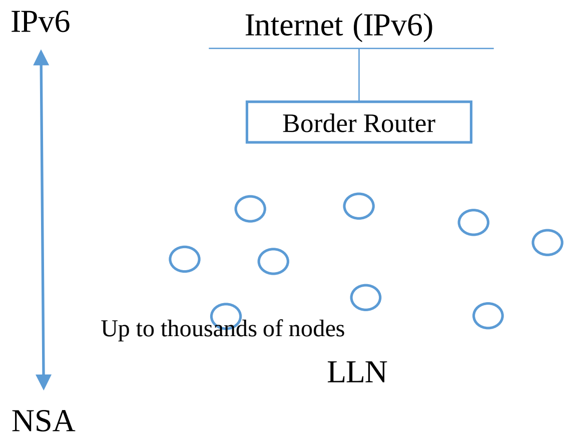
← Header length reduces 43% !

- LOWPAN_IPHC (context free and route over case)

0	1	1	TF	NH	HLIM	C I D	S A C	SAM	M	D A C	DAM	SCI	DCI	Source Address	Destination Address
8b						8b						8b		16b	16b

Overview

NSA (Native Short Address): A distributed assigned network layer identifier for efficient routing. It’s normally local effected and using smaller address space than IPv6.

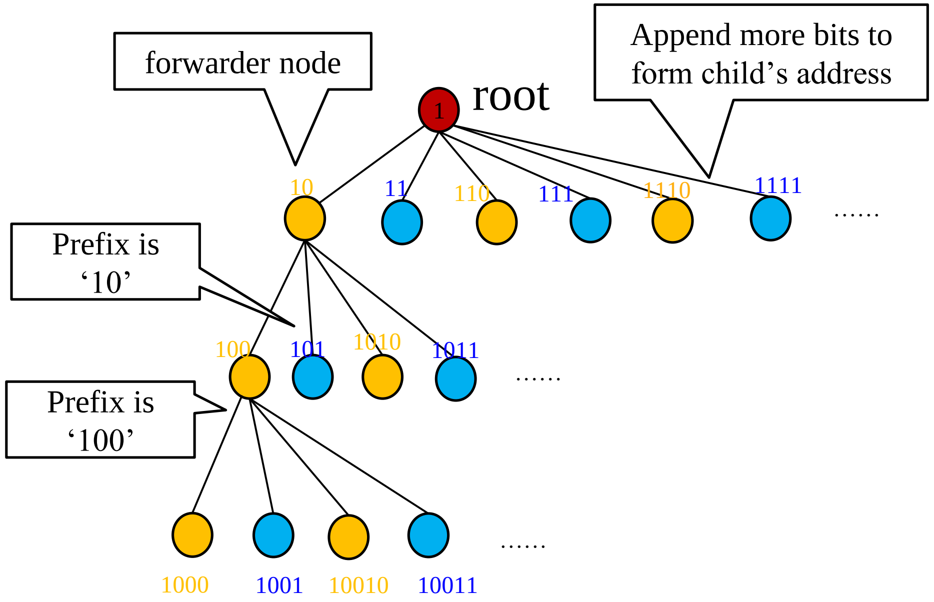


- Key techniques of NSA：
  - NSA allocation
  - native table-free routing
  - Address header avoiding context and address compression
- Minimum Packet Overhead for energy saving

NSA Allocation

Algorithm consumptions:

- There are 3 roles for network nodes, **root/forwarder/leaf**.
- Root's address will always be '1', forwarder's address ends with '0', leaf's address ends with '1'.
- Normally, the root role is configured to border router before the LLN startup.
- All child nodes' address will start with their parent's address.



What does an example looks like

NSA Allocation core function is defined as:

```
A(role, i) = 'root/forwarder address'
           + (i-1)*'1'
           + (role == leaf?'1':'0'),
in which, i is index of leaf/forwarder at this layer.

Figure 4: Definition of the allocation function of forwarder/root
nodes.
```

NSA Allocation (1)

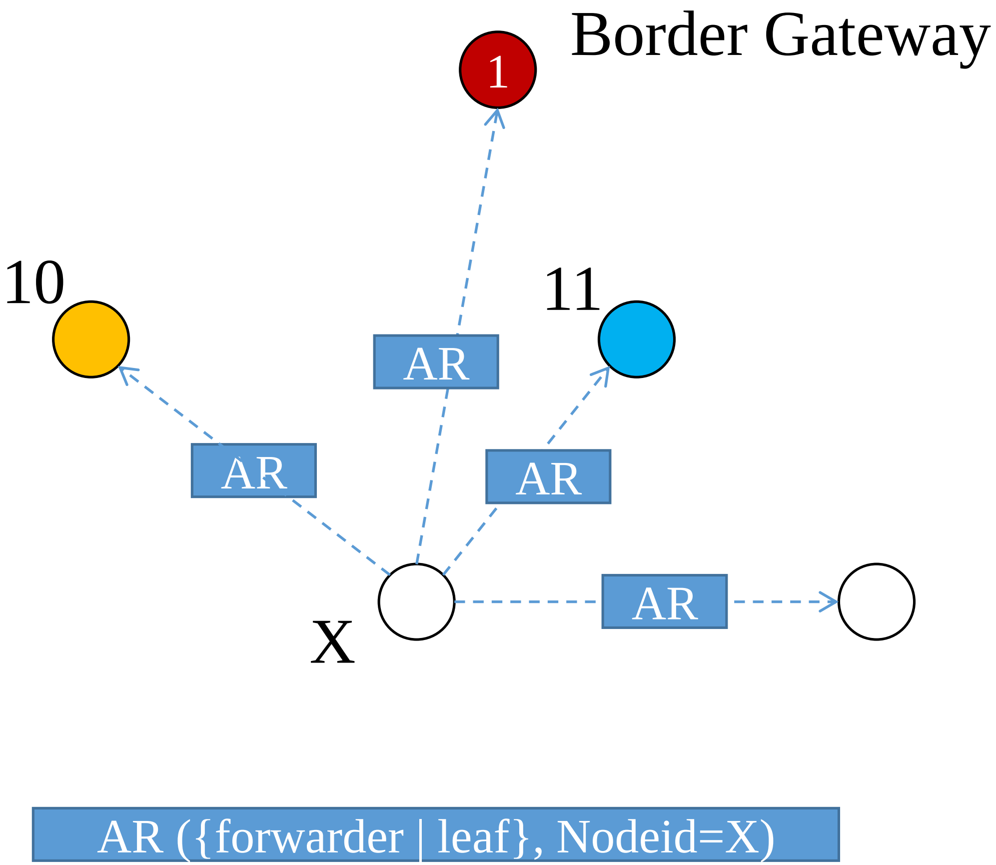
Node with no address

Root Node: NSA is always ‘1’

Forwarder: NSA is like ‘1xxx0’

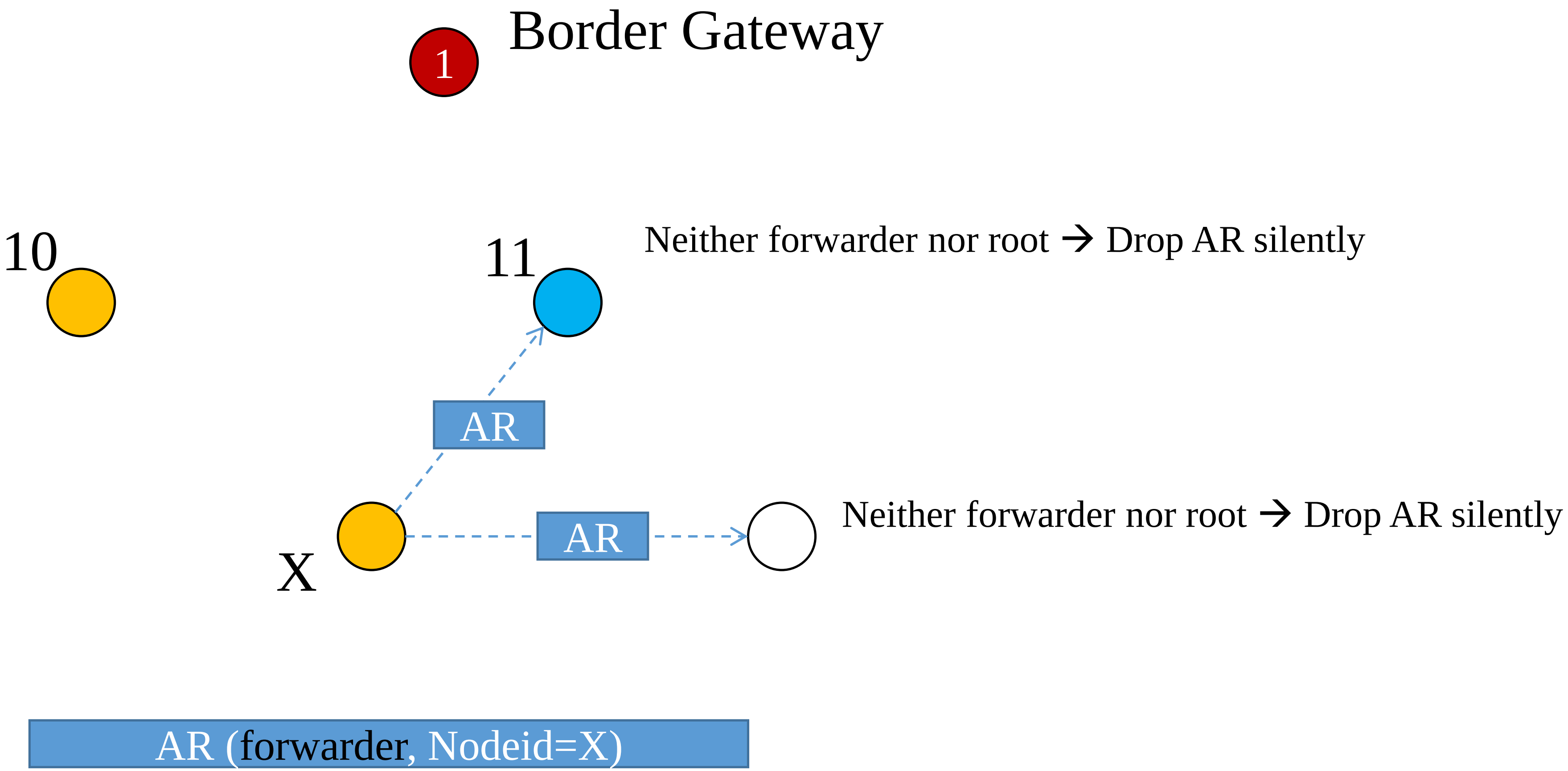
Leaf Node: NSA is like ‘1xxx1’

NSA Allocation (2)



AR – Address Request

NSA Allocation (3.1)



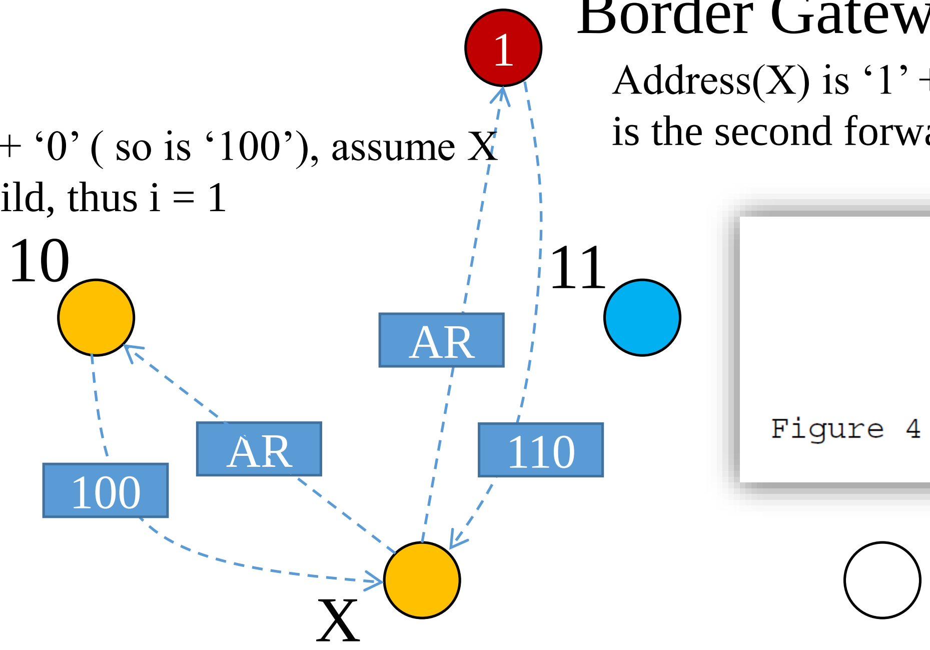
AR – Address Request

NSA Allocation (3.2)

Border Gateway

Address(X) is ‘1’ + ‘1’ + ‘0’ (so is ‘110’), assume X is the second forwarder child, thus i = 2

Address(X) is ‘10’ + ‘’ + ‘0’ (so is ‘100’), assume X is the first forwarder child, thus i = 1

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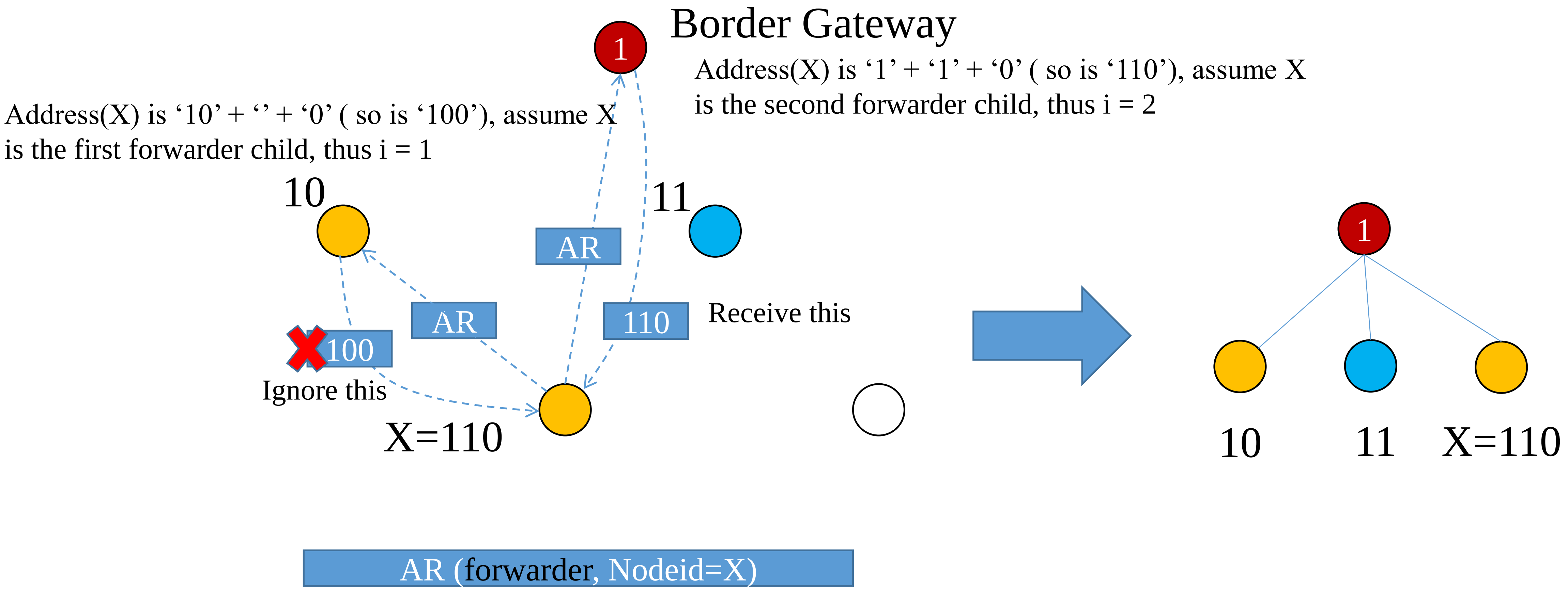
```

Figure 4: Definition of the allocation function of forwarder/root nodes.

AR (forwarder, Nodeid=X)

AR – Address Request

NSA Allocation (4)



AR – Address Request

Native table-free routing

Routing within the domain:

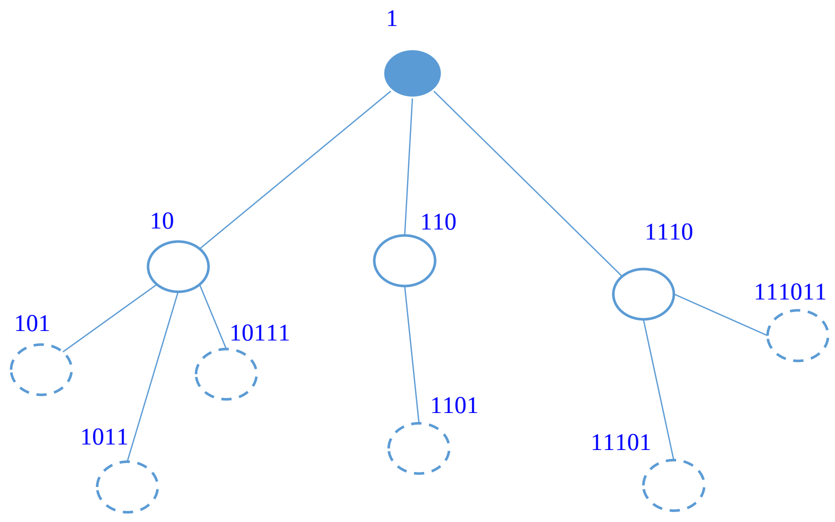
Rule 1: If the destination equals to current node's address, complete routing.

Rule 2: If current node is originating node and leaf, send packet to its parent;

Rule 3: If current node is router and its address is prefix of DA(Destination Address), calculate next hop address. Check values from bits next to prefix, skip '1' until the first '0', to form a new longer prefix. This prefix should be direct child of current node.

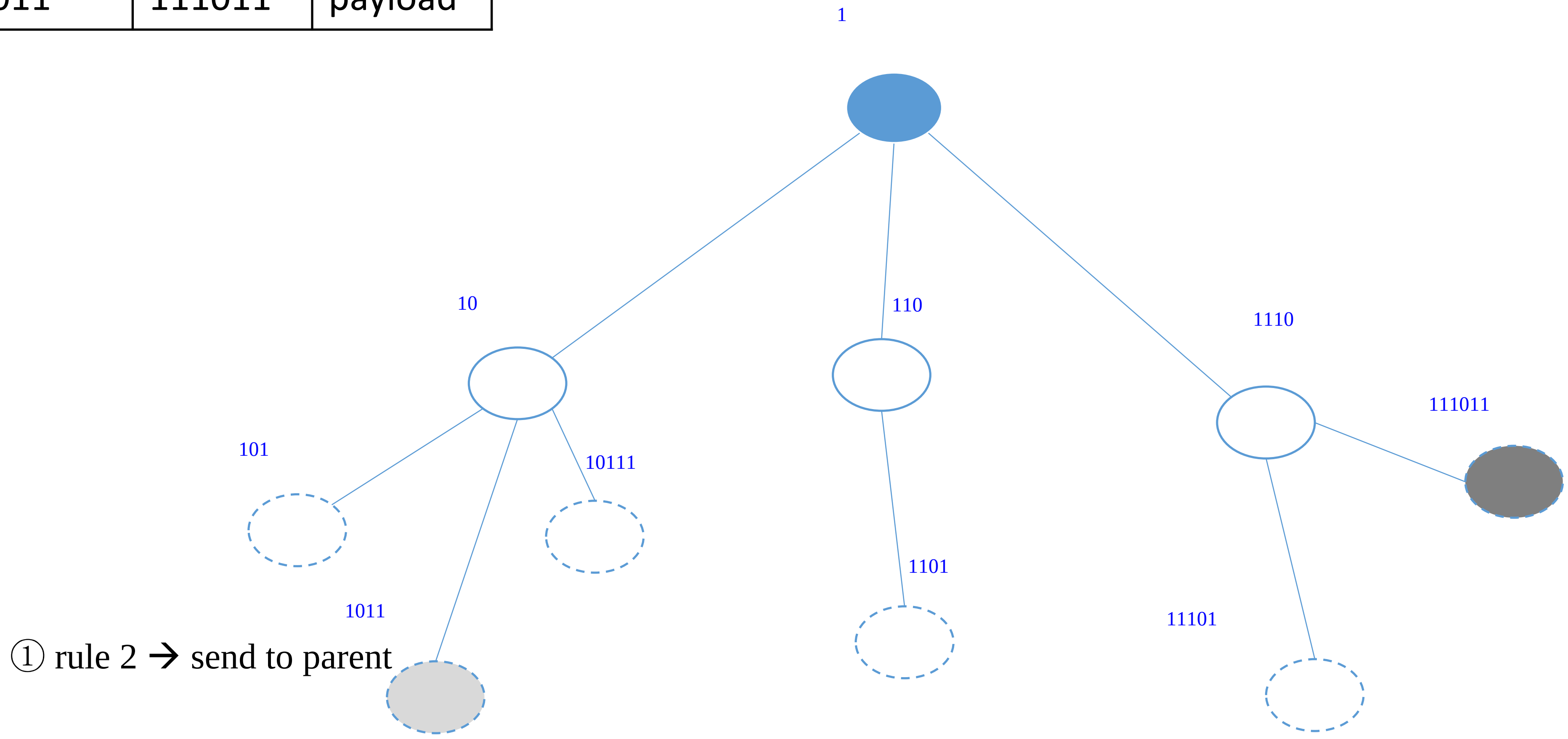
Rule 4: If current node is not root, send packet to parent

Default Rule: drop and error report



Native table-free routing example (1)

1011	111011	payload

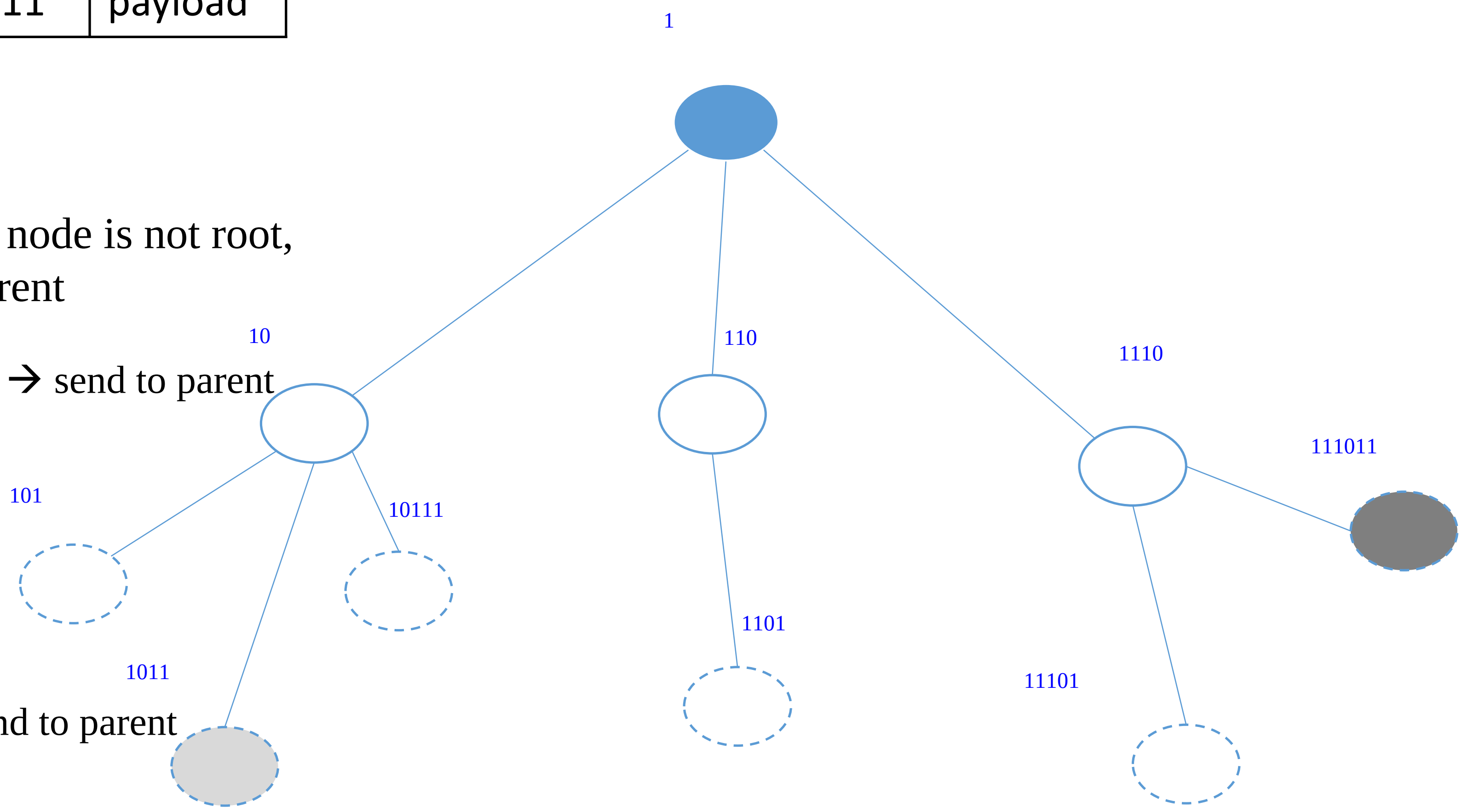


Rule 2: If current node is originating node and leaf, send packet to its parent;

Native table free routing example (2)

1011	111011	payload

Rule 4: If current node is not root, send packet to parent



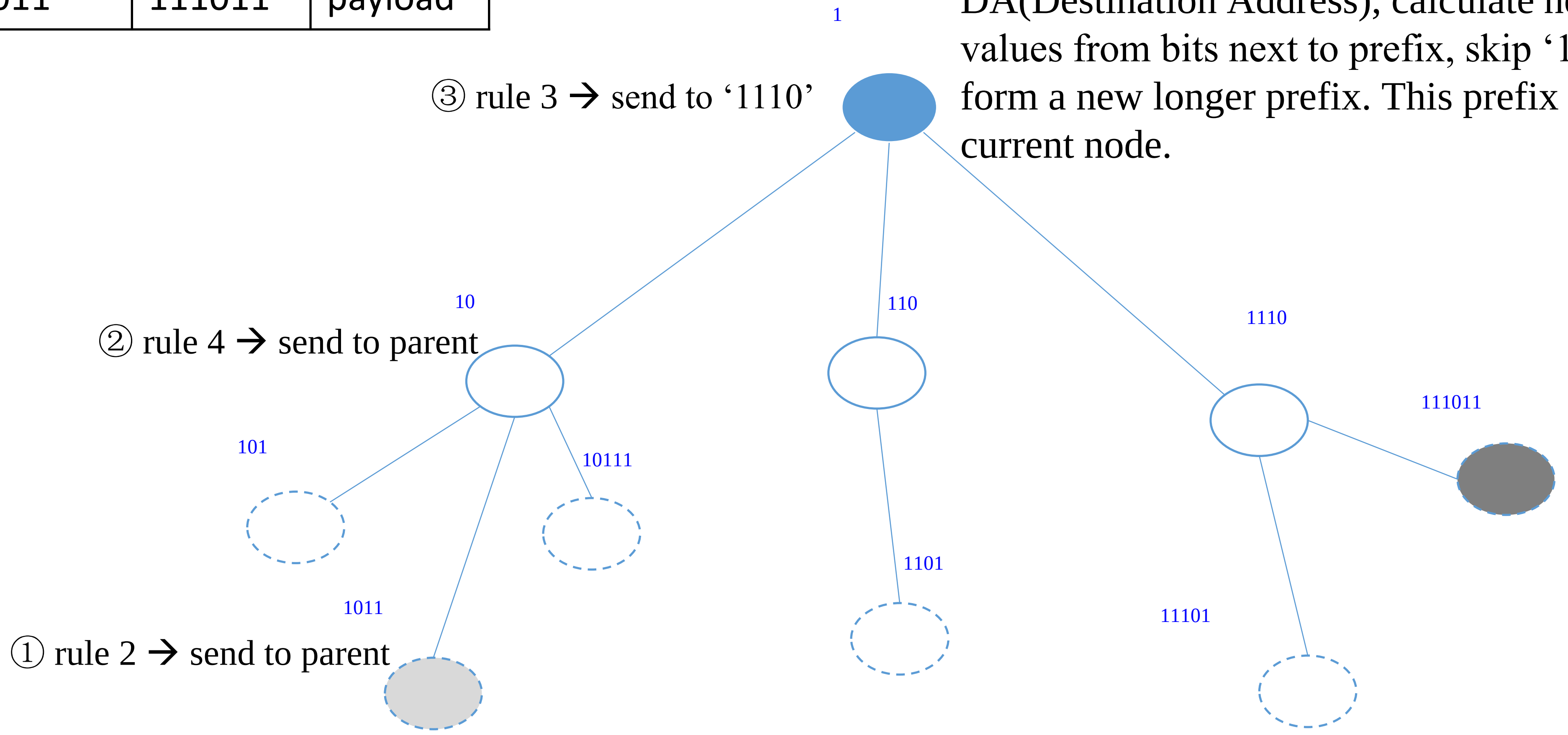
② rule 4 → send to parent

① rule 2 → send to parent

Native table-free routing example (3)

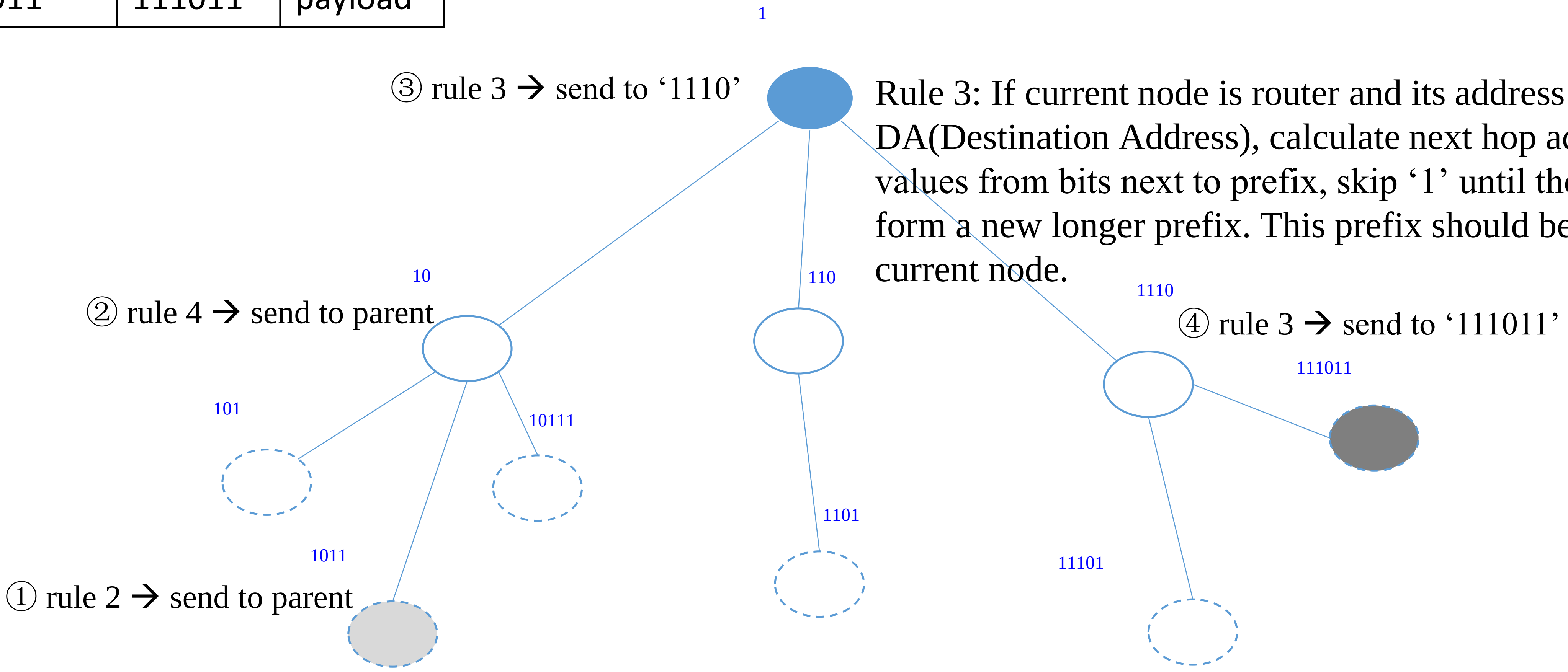
1011	111011	payload

Rule 3: If current node is router and its address is prefix of DA(Destination Address), calculate next hop address. Check values from bits next to prefix, skip '1' until the first '0', to form a new longer prefix. This prefix should be direct child of current node.



Native table free routing example (4)

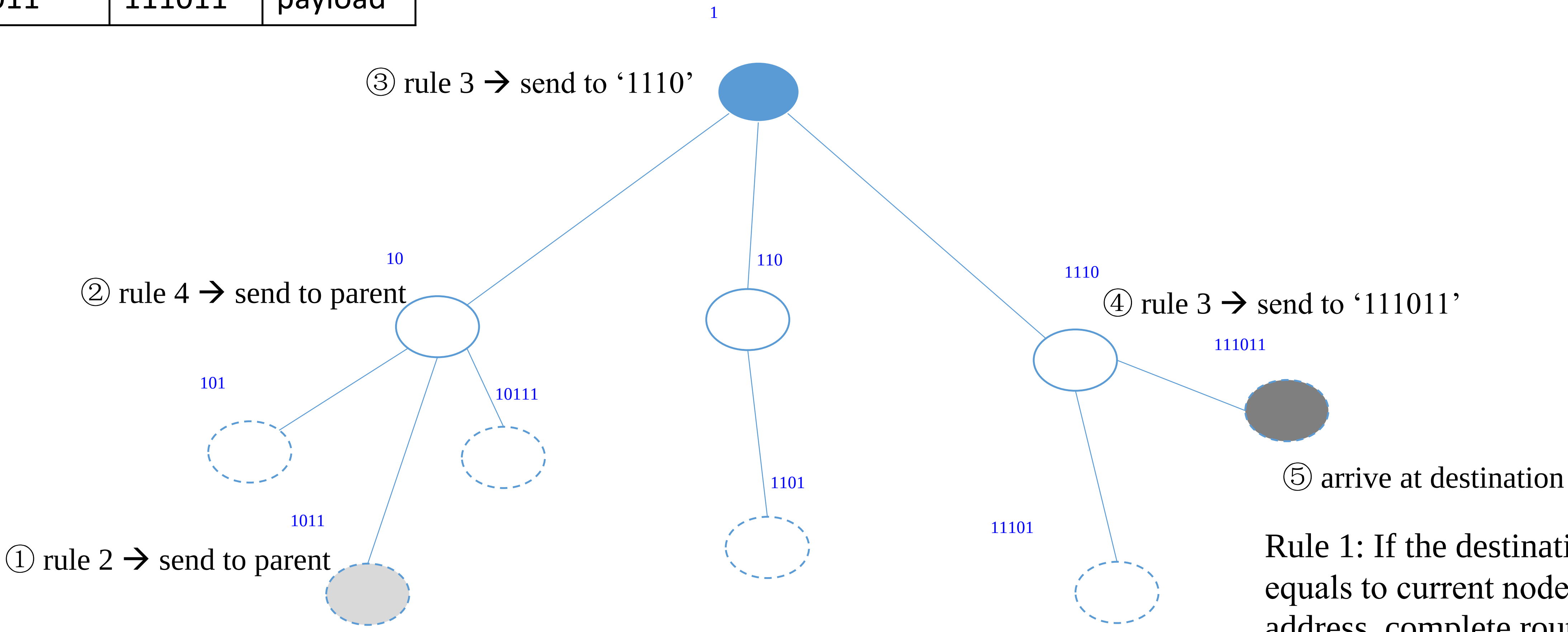
1011	111011	payload



Rule 3: If current node is router and its address is prefix of DA(Destination Address), calculate next hop address. Check values from bits next to prefix, skip '1' until the first '0', to form a new longer prefix. This prefix should be direct child of current node.

Native table-free routing example (5)

1011	111011	payload



Rule 1: If the destination equals to current node's address, complete routing.

Routing between native and IPv6 domain

1. **For inwards traffic (from IPv6 to NSA):**
   a. The border router(root) can keep IPv6 prefixes for nodes in the domain. Remove DA's prefix to form native short address.
   b. The root may get native short address(an index of address mapping) for SA.
   c. native table-free routing will be used for packet transmission.

2. **For upwards traffic:**
   a. Border router maintain a table mapping IPv6 destinations to native short addresses.
   b. Packet carries an index of table item when transmitting in the domain.
   c. Border router will look up real IPv6 destination before sending the packets to IPv6 domain.

Packet Header encoding

0101	TF	NH	HL	Payload Length（variable length）	i/o	AM	SA	DA	In-line fields……
0			7	15			23	31	

- New Dispatch Type —— LOWPAN-NIP
  - ✓ 0101 0000~0101 1111
- TF: inherit from LOWPAN_IPHC， except TF here can not be 00.
- NH: inherit from LOWPAN_IPHC, using LOWPAN_NHC
- HL: hop limit. 0 – hop limit field located in in-line fields; 1 – no hop limit header, using default value 64
- Payload Length: Default is 8 bits. Using length-variable encoding. Assume most packets are smaller than 252 bytes. If no, payload length expands to 2 or 3 bytes.
- i/o: 0 – outwards traffic from inner node to IPv6 node outside;1- inwards traffic from IPv6 node outside to inner node.
- AM(Address Mode): full IPv6 Address(0) in SA/DA, or native short address(1) mapping to IPv6 in SA/DA.
- SA: if i/o =0, means SA is native source address; if i/o =1, means SA is IPv6 or mapped NSA
- DA: if i/o =1, means DA is native destination address; if i/o=0, means DA is IPv6 or mapped NSA

Variable-length encoding

- **Payload Length:**
  - ✓ 0~252: indicate how many octets the payload consist of.
  - ✓ 253: indicate there’s extra one octet for payload length, the actual length value equals last byte value plus 252.
  - ✓ 254: indicate there’s extra two octets for payload length, the actual length value equals value of last two bytes plus 252.
  - ✓ 255: reserved…
- **Native Short Address:**
  - ✓ 0~252: if the address value locates in this interval, using one octet encoding the value
  - ✓ 253: indicate encapsulating the address in the following 2 octets.
  - ✓ 254: indicate the following 4 octets encoding the address.
  - ✓ 255: indicate the following octet storing the length of address in octet. Then the address value octets follows.

Evaluation:

Improvements:

- ✓ Simpler routing algorithm in domain
  - ➢ native short address encoded topology location information， thus table-free
  - ➢ No tunnel， No segment routing
- ✓ Eliminate all stateful context
  - ✓ No address compression in the limited domain
- ✓ More bits saving in headers
  - Best case： 6lowpan 7 bytes vs. NSA 4 bytes

IANA consideration

- New Dispatch Type —— LOWPAN-NIP
  - ✓ 0101 0001~0101 1111

https://www.iana.org/assignments/_6lowpan-parameters/_6lowpan-parameters.xhtml#_6lowpan-parameters-1

Next？

Welcome people who are interested to work further

- Write and co-author drafts and standardize it
- Point out any possible improvement
- Tell us related information we didn’t know
- …

Request 6lo WG accept this work (partly?)

- A new general approach to facilitate IPv6 connectivity over constrained node networks
- This document need new dispatch type assignment

Thanks