DNSNA: DNS Name Autoconfiguration for Internet of Things Devices

(draft-jeong-6man-iot-dns-autoconf-00)

http://datatracker.ietf.org/doc/draft-jeong-6man-iot-dns-autoconf/

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Motivation: IoT Location-Based Service

Text-based Display of Devices
by AllSeen Alliance

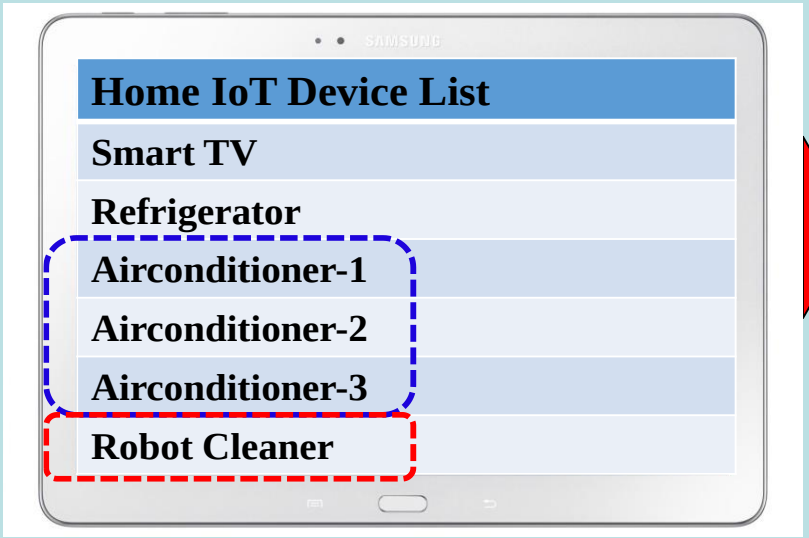
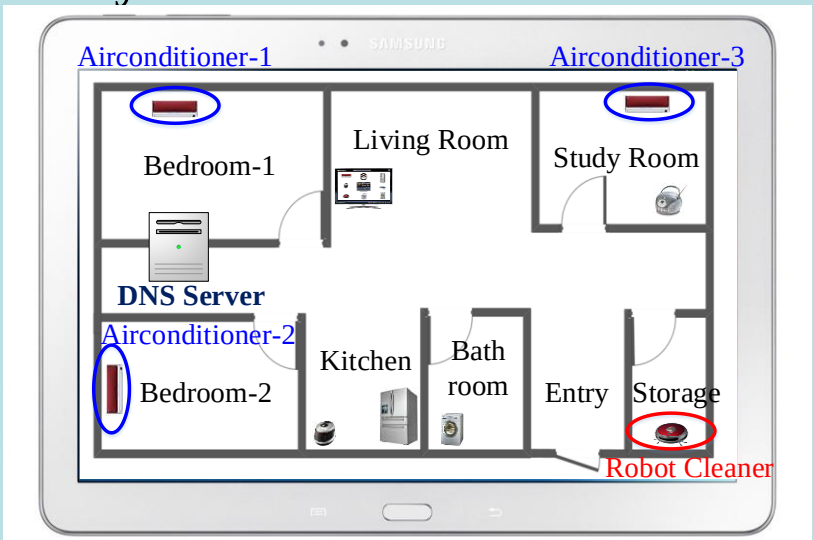


Image-based Display of Devices
by DNSNA and Localization



❖ Goal

- **Global (or Local) DNS Name Configuration for IoT Device DNS Name**
  - ➢ Can be automated without the intervention of a network administrator (or home users).

❖ Applicability Domains

- **Home, Office, Smart grid, Road network, Mall (e.g., Wal-Mart and Best Buy), and Factory (e.g., GM and Hyundai)**

DNS Name Format

❖ DNS Name Format 1:

unique_id.device_model.device_category.location.domain_name

- **unique_id:** Unique identifier to guarantee the uniqueness
- **device_model:** Product model of manufacturer name
- **device_category:** Device category name
- **location:** Physical location of the device (e.g., kitchen)
- **domain_name:** Representation and use of domain name (e.g., home, skku.edu)

❖ DNS Name Format 2:

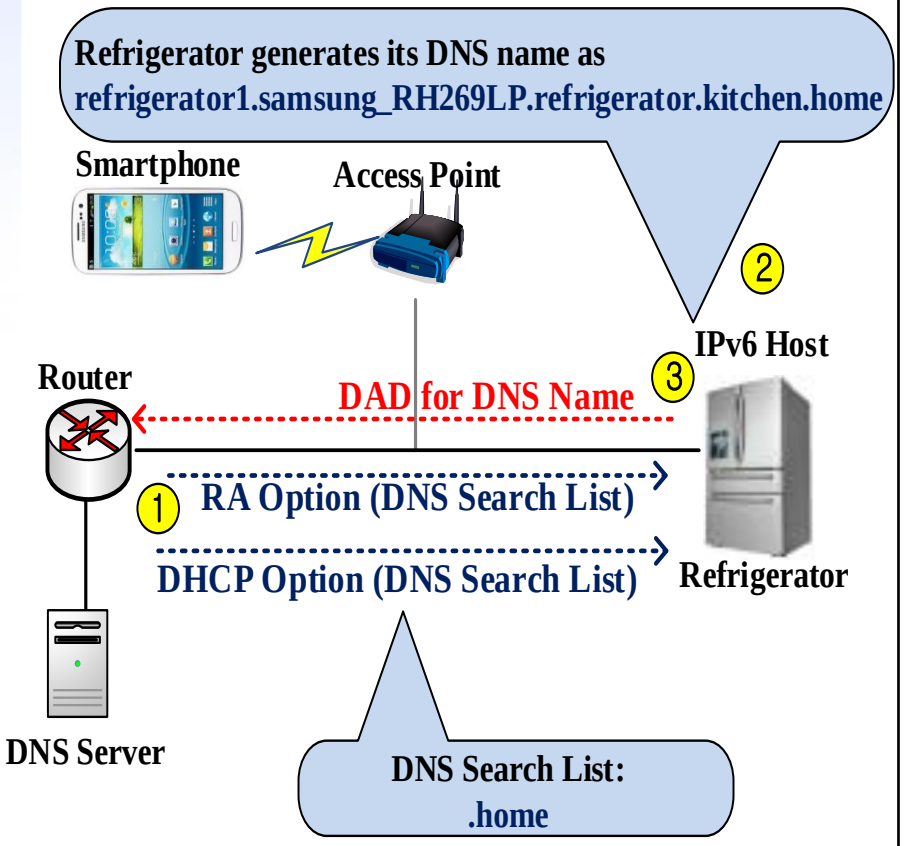
unique_id.object_identifier.location.domain_name

- **unique_id:** Unique identifier to guarantee the uniqueness
- **object_identifier:** Object identifier standardized by ITU-T and ISO/IEC
  - Node Indication ID + Manufacturer ID + Model ID + Serial Number ID
- **location:** Physical location of the device (e.g., kitchen)
- **domain_name:** Representation and use of domain name (e.g., home, skku.edu)

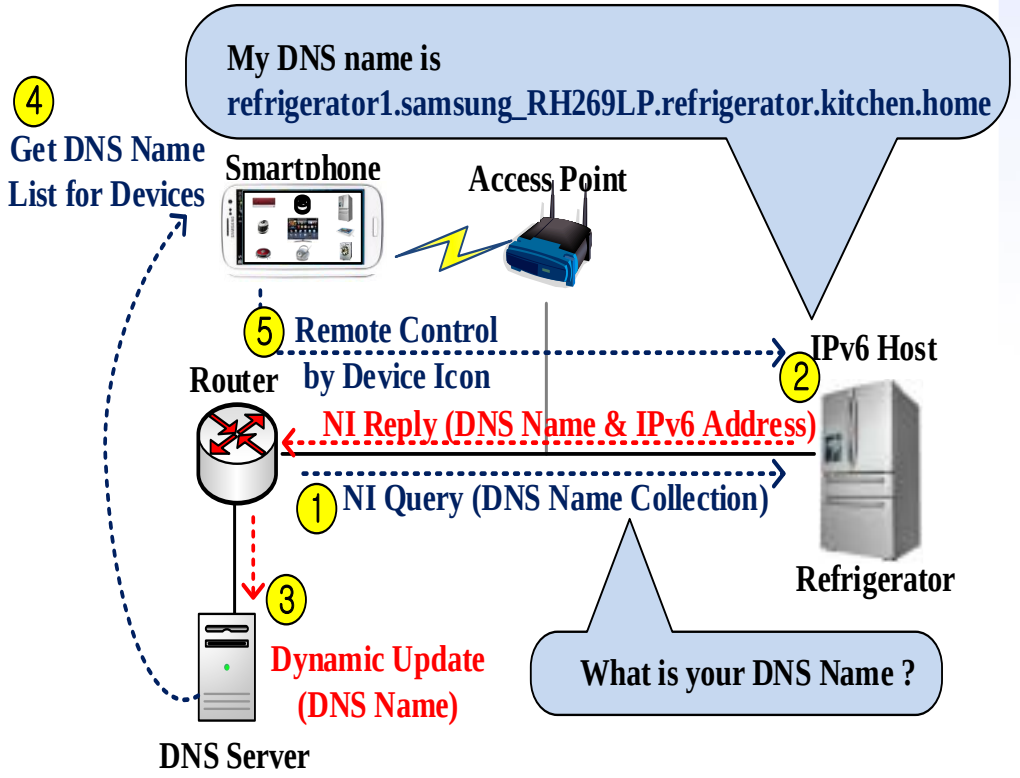
Protocol of DNS Name Autoconfiguration

❖ Generation and Registration of IoT Device's DNS Name

1. DNS Name Generation

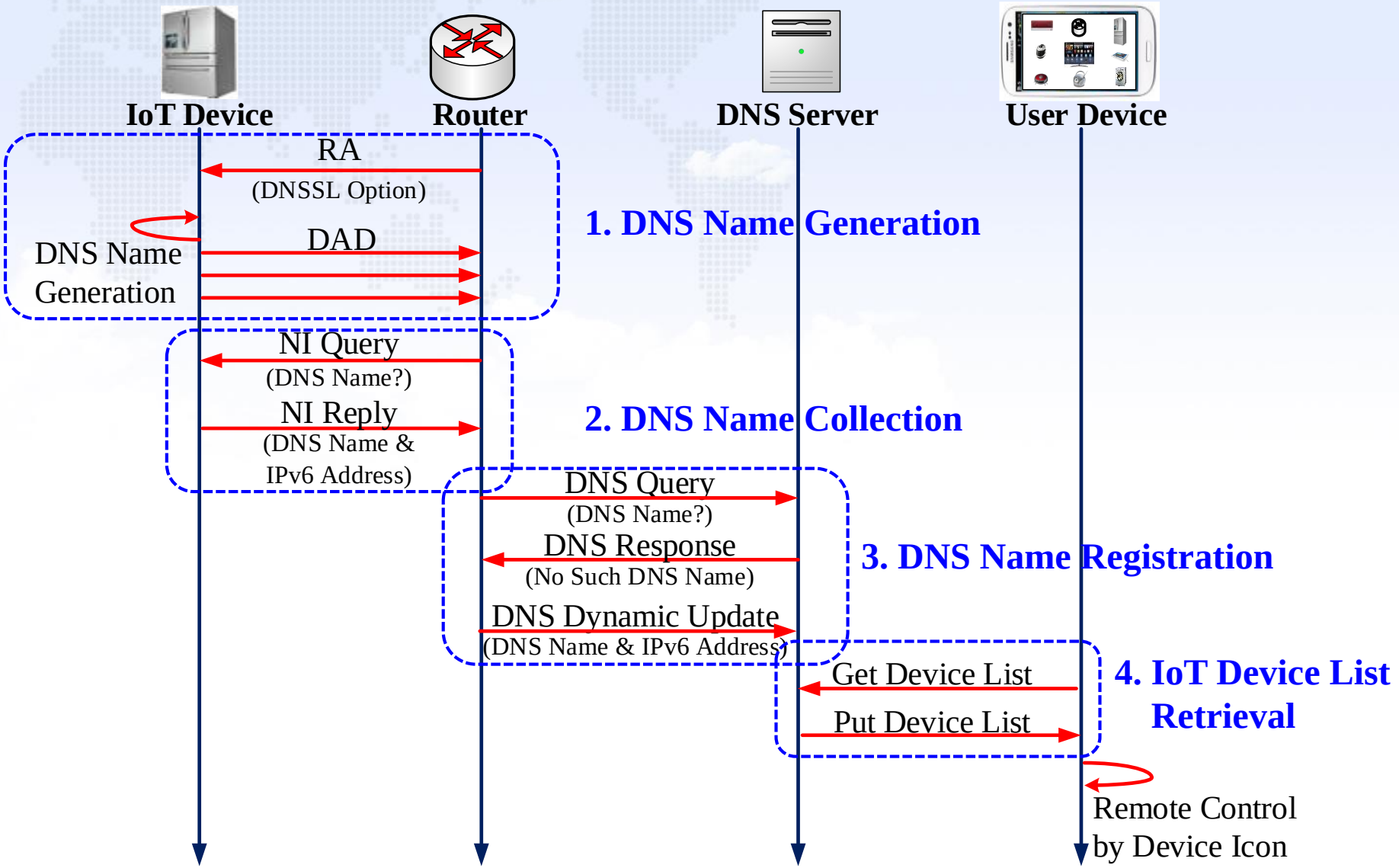


2. DNS Name Registration



Appendix Slides

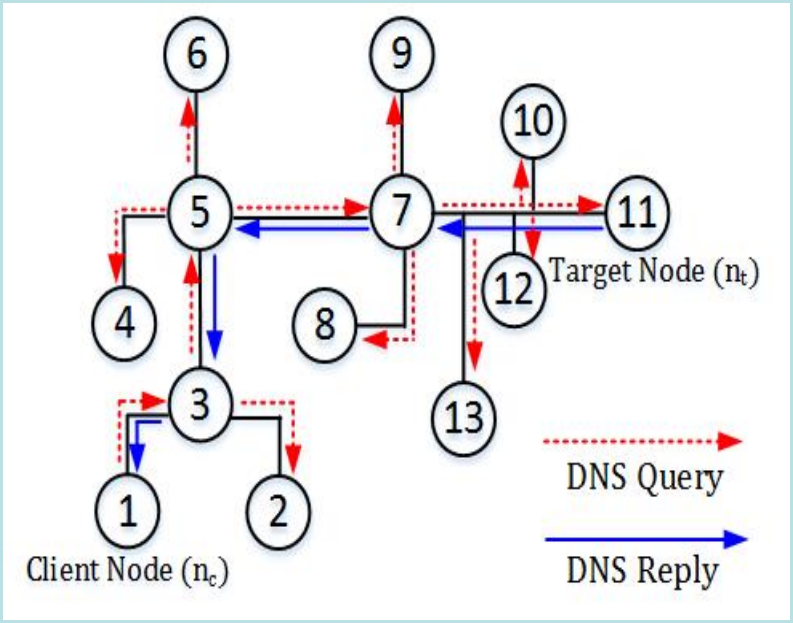
Time Sequence Diagram of DNSNA



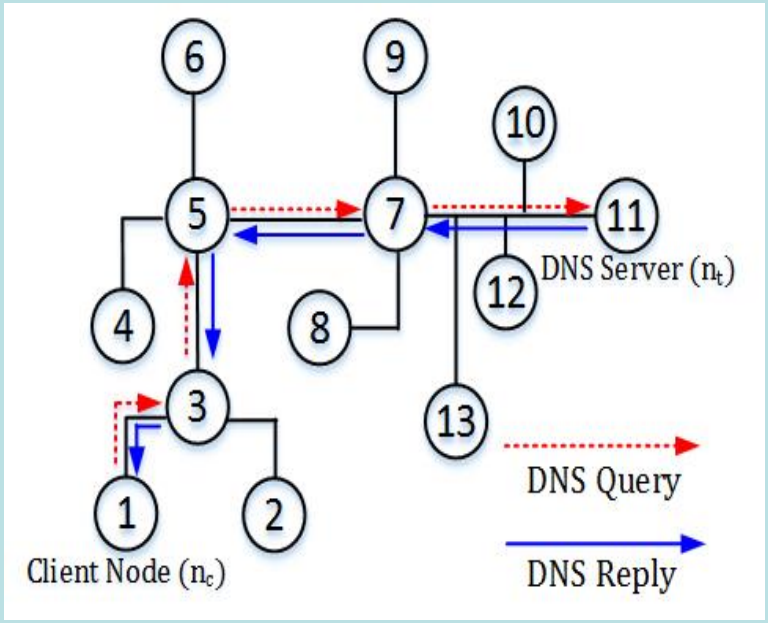
Network Topology

- **Comparison between mDNS & DNSNA in terms of DNS Traffic for DNS Name Resolution in a Multi-link Network**

DNS Name Resolution at mDNS



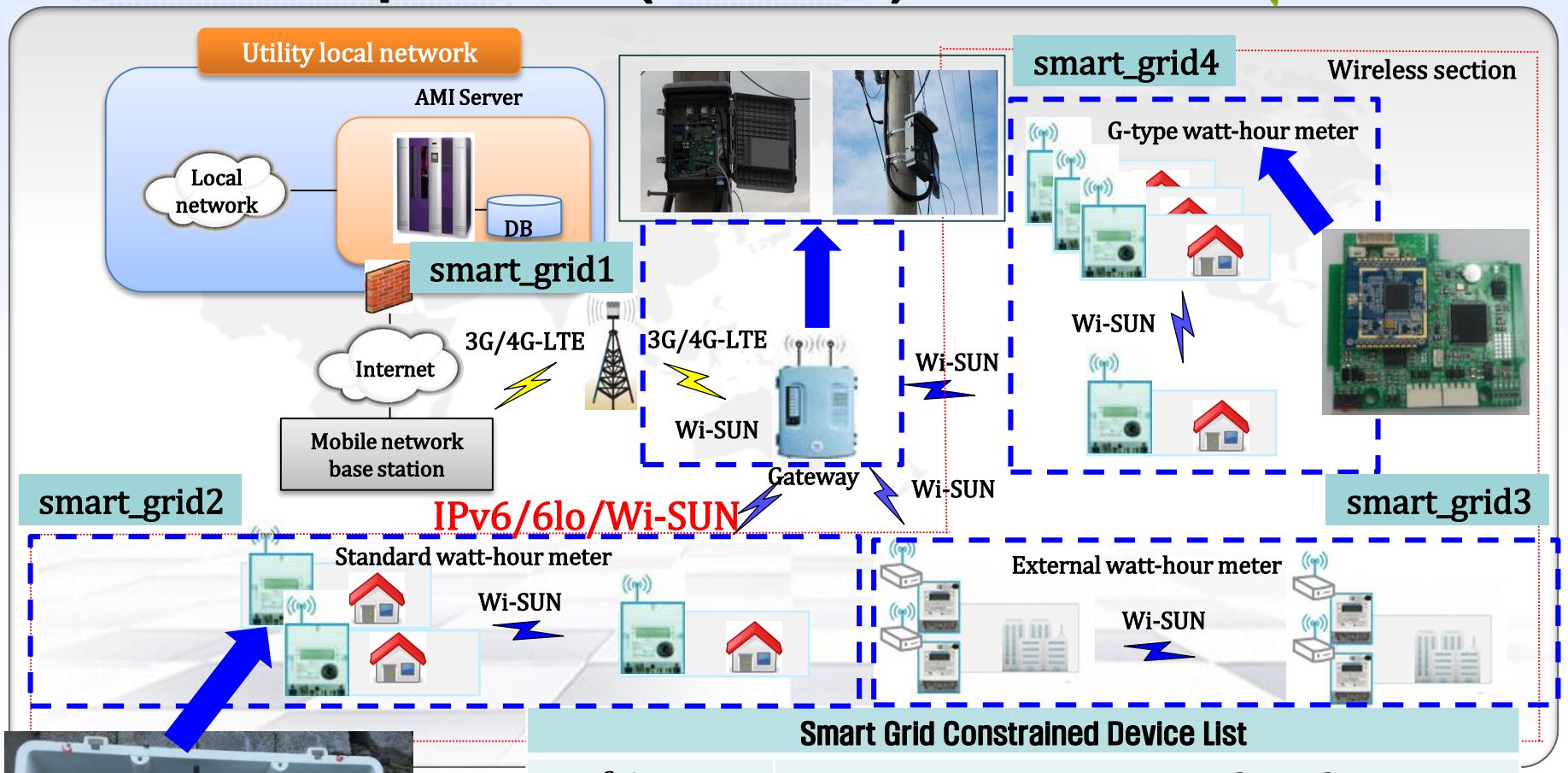
DNS Name Resolution at DNSNA



DNSNA vs. mDNS (RFC6762)

Approaches	DNSNA	mDNS
Packet Forwarding	Unicasting	Multicasting
Authoritative DNS Server	Yes	No (host itself is server)
Naming Scope	Global, Local	Local
Target Networks	Small, Large	Small
Socket	RAW/IPv6	UDP/IPv6
Host Implementation	A little extension of ND	mDNS implementation required
Code Size	Hundreds lines	Thousands lines
Target Devices	Constrained Devices	Apple Equipment
Message Number	2 x #hops of the path from client to DNS server	#links in the network + #hops from target to client

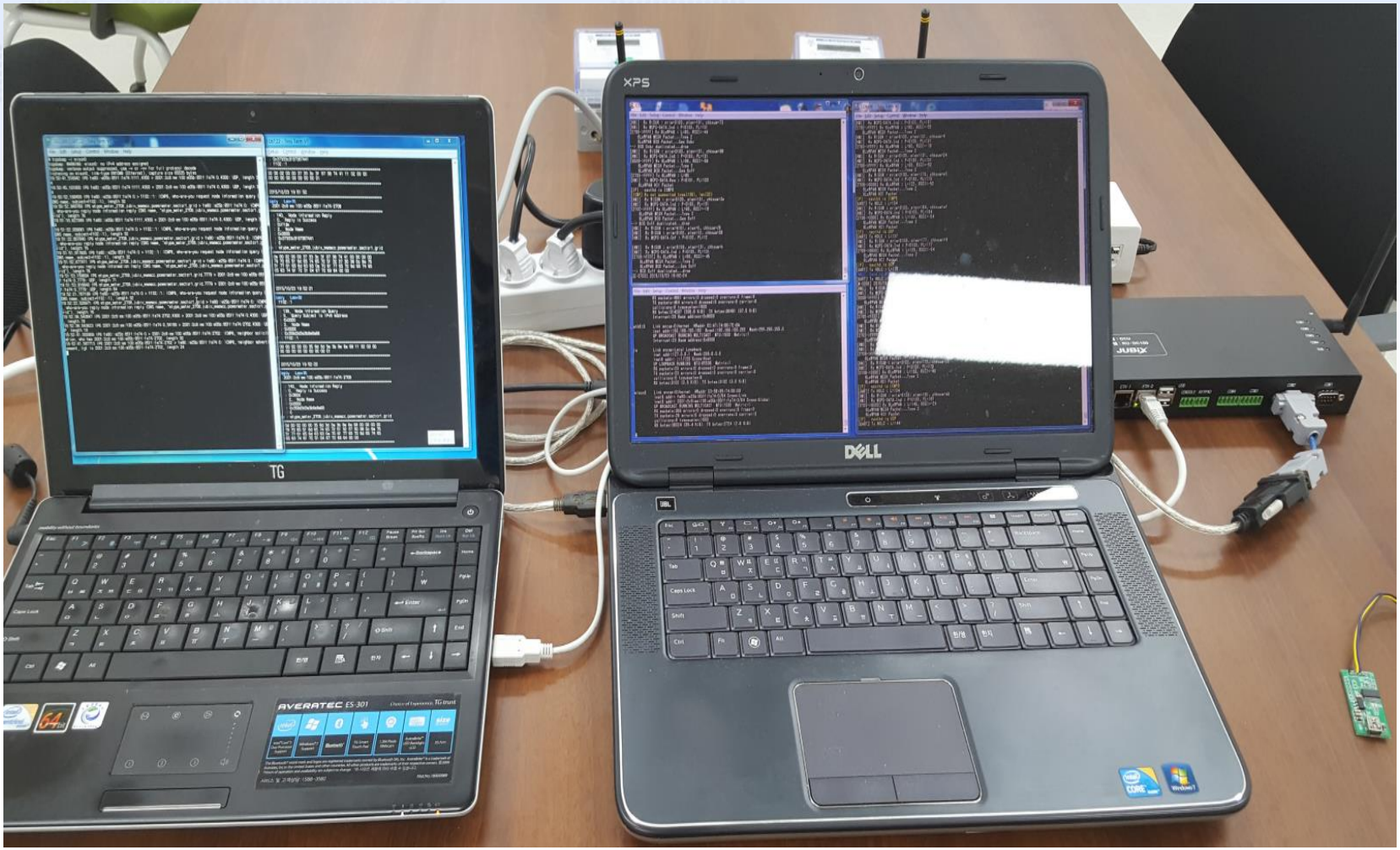
Applicability Domain: Smart Grid in Korea Electric Power Corporation (KEPCO) for Pilot Service



Smart Grid Constrained Device List	
Gateway	*gateway.smart_grid1.grid*
Standard_meter1	*standard_meter1.smart_grid2.grid*
Standard_meter2	*standard_meter2.smart_grid2.grid*
External_meter1	*external_meter1.smart_grid3.grid*
External_meter2	*external_meter2.smart_grid3.grid*
G_type_meter1	*g_type_meter1.smart_grid4.grid*

Demonstration Devices (1/2)

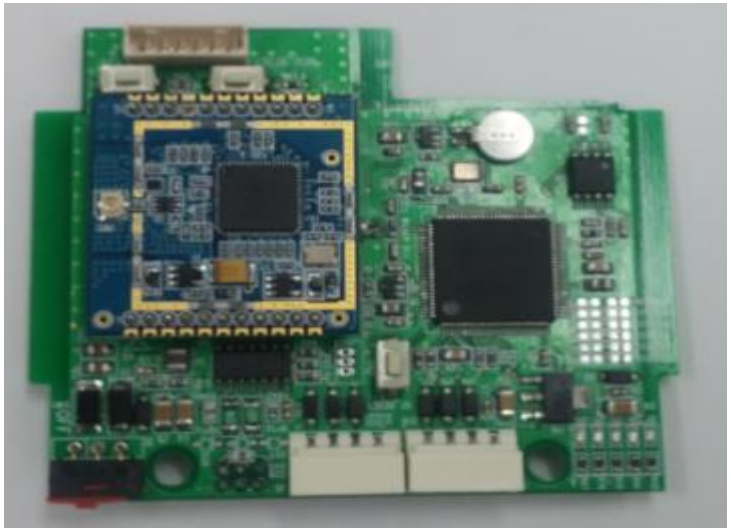
❖ System Environment



Demonstration Devices (2/2)

❖ Gateway

❖ Meter (Constrained Device)



DNSNA Configuration

❖ Features

Parameter	Gateway	Meter
OS	Linux	FreeRTOS
CPU	ARM Cortex-A5	ARM Cortex-M4
RAM	DDR2 256 Mbyte	64K-byte embedded SRAM
Flash Memory	256 Mbyte	256/512 Kbytes

❖ The Configuration of Router Advertisement Daemon (radvd)

```
Interface wisun0
{
        AdvSendAdvert on;
        MinRtrAdvInterval 600;
        MaxRtrAdvInterval 1800;

        Prefix 2001:2c8:ee:100::/64
        {
                AdvOnLink on;
                AdvAutonomous on;
                AdvRouterAddr off;
        };

        RDNSS 2001:2c8::1
        {
                AdvRDNSSLifetime 3600;
        };
        DNSSL secter1.grid
        {
                AdvDNSSLifetime 3600;
        };
};
```

Demonstration of DNSNA (1/5)

❖ **Router Advertisement (One Gateway and Two Meters)**

Gateway

```
# tcpdump_dlb -i wisun0 icmp6
tcpdump_dlb: WARNING: wisun0: no IPv4 address assigned
tcpdump_dlb: verbose output suppressed, use -v or -vv for full protocol decode
listening on wisun0, link-type EN10MB (Ethernet), capture size 65535 bytes
03:16:23.670986 IP6 fe80::e05b:85ff:fe74:cc02 > ff02::2: ICMP6, router solicitation, length 16
03:16:23.674002 IP6 fe80::e25b:85ff:fe74:0 > ff02::1: ICMP6, router advertisement, length 80
03:16:24.685071 IP6 :: > ff02::1:ffba:51ef: ICMP6, neighbor solicitation, who has fe80::107d:97f9:43ba:51ef, length 24
03:16:24.935606 IP6 :: > ff02::1:ff25:ebc5: ICMP6, neighbor solicitation, who has fe80::5350:bced:5825:ebc5, length 24
```

Meter 1

```
[ICMP] Recv RA : L=80
Router Addr : fe 80 00 00 00 00 00 00 e2 5b 85 ff fe 74 00 00
    option dnssl L=16, 07 73 65 63 74 65 72 31 04 67 72 69 64 00 00 00
    DNS Search List : L=12, secter1.grid
Make DNS Name AutoConf : L=53, gtype_meter_cc14.jubix_wagmcc.powermeter.secter1.grid
    Wire Domain Name : L=56
    [16] gtype_meter_cc14
    [12] jubix_wagmcc
    [10] powermeter
    [ 7] secter1
    [ 4] grid
```

Meter 2

```
[ICMP] Recv RA : L=80
Router Addr : fe 80 00 00 00 00 00 00 e2 5b 85 ff fe 74 00 00
    option dnssl L=16, 07 73 65 63 74 65 72 31 04 67 72 69 64 00 00 00
    DNS Search List : L=12, secter1.grid
Make DNS Name AutoConf : L=53, etype_meter_cc02.jubix_waemcc.powermeter.secter1.grid
    Wire Domain Name : L=56
    [16] etype_meter_cc02
    [12] jubix_waemcc
    [10] powermeter
    [ 7] secter1
    [ 4] grid
```

Demonstration of DNSNA (2/5)

- Duplicate Address Detection (DAD) for DNS Names

Meter 1

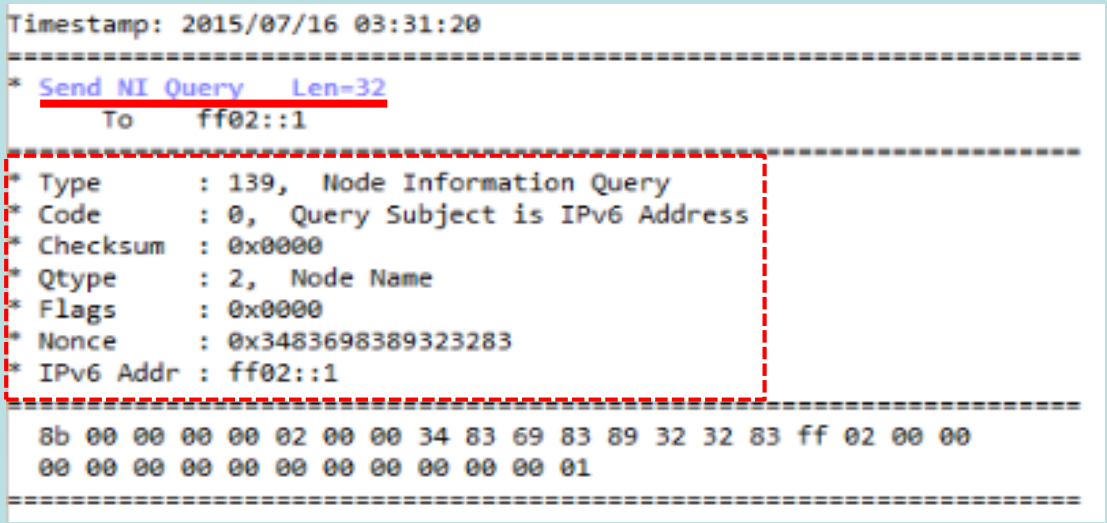
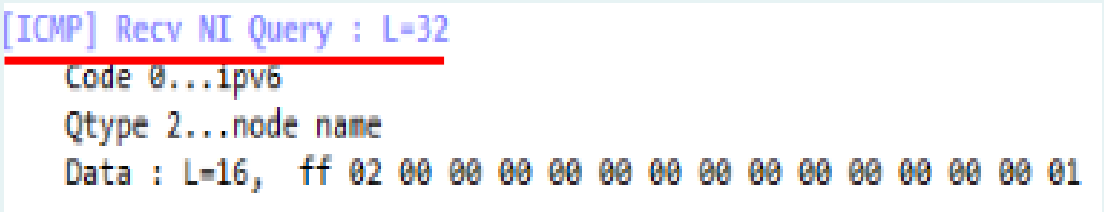
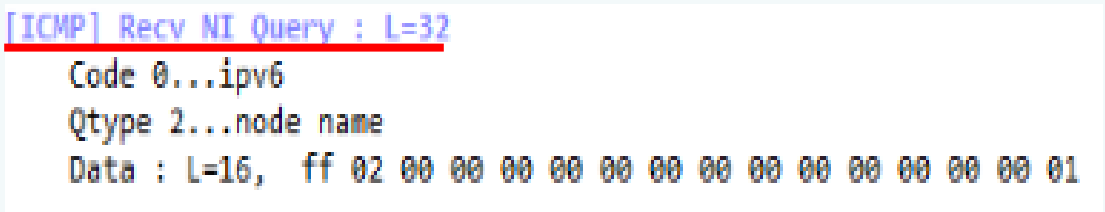
```
Make DNS Name MD5 Addr : fe 80 00 00 00 00 00 00 53 50 bc ed 58 25 eb c5

Check DAD for DNS Name
[NDP]   Send NS : L=24
    option target L=16, fe 80 00 00 00 00 00 00 53 50 bc ed 58 25 eb c5
[6LoW] tx next hop is broadcast
[CC14->FFFF] Tx 6LoWPAN : L=80
[HMI]   Tx MCPS-DATA.Req : P=0101, PL=120
[HMI]   Rx MCPS-DATA.Cnf : P=0102, PL=12

Check DAD for DNS Name
[NDP]   Send NS : L=24
    option target L=16, fe 80 00 00 00 00 00 00 53 50 bc ed 58 25 eb c5
[6LoW] tx next hop is broadcast
[CC14->FFFF] Tx 6LoWPAN : L=80
[HMI]   Tx MCPS-DATA.Req : P=0101, PL=120
[HMI]   Rx MCPS-DATA.Cnf : P=0102, PL=12

Check DAD for DNS Name
[NDP]   Send NS : L=24
    option target L=16, fe 80 00 00 00 00 00 00 53 50 bc ed 58 25 eb c5
[6LoW] tx next hop is broadcast
[CC14->FFFF] Tx 6LoWPAN : L=80
[HMI]   Tx MCPS-DATA.Req : P=0101, PL=120
[HMI]   Rx MCPS-DATA.Cnf : P=0102, PL=12
```

Meter 2

```
Make DNS Name MD5 Addr : fe 80 00 00 00 00 00 00 10 7d 97 f9 43 ba 51 ef

Check DAD for DNS Name
[NDP]   Send NS : L=24
    option target L=16, fe 80 00 00 00 00 00 00 10 7d 97 f9 43 ba 51 ef
[6LoW] tx next hop is broadcast
[CC02->FFFF] Tx 6LoWPAN : L=80
[HMI]   Tx MCPS-DATA.Req : P=0101, PL=120
[HMI]   Rx MCPS-DATA.Cnf : P=0102, PL=12

Check DAD for DNS Name
[NDP]   Send NS : L=24
    option target L=16, fe 80 00 00 00 00 00 00 10 7d 97 f9 43 ba 51 ef
[6LoW] tx next hop is broadcast
[CC02->FFFF] Tx 6LoWPAN : L=80
[HMI]   Tx MCPS-DATA.Req : P=0101, PL=120
[HMI]   Rx MCPS-DATA.Cnf : P=0102, PL=12

Check DAD for DNS Name
[NDP]   Send NS : L=24
    option target L=16, fe 80 00 00 00 00 00 00 10 7d 97 f9 43 ba 51 ef
[6LoW] tx next hop is broadcast
[CC02->FFFF] Tx 6LoWPAN : L=80
[HMI]   Tx MCPS-DATA.Req : P=0101, PL=120
[HMI]   Rx MCPS-DATA.Cnf : P=0102, PL=12
```

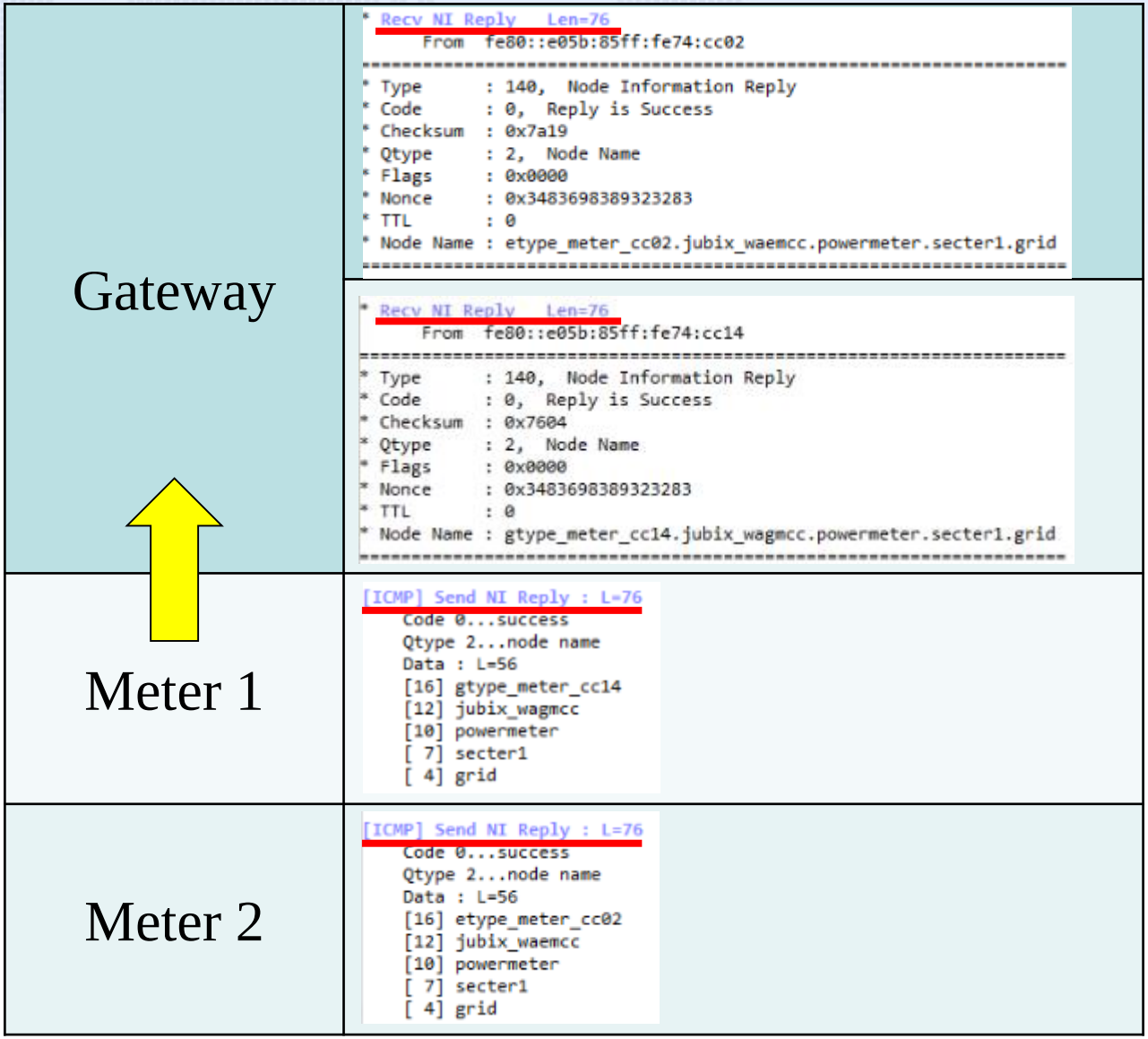
Demonstration of DNSNA (3/5)

❖ **Node Information Query for DNS Name Collection**

Gateway	
Meter 1	
Meter 2	

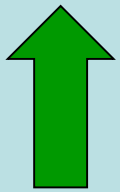
Demonstration of DNSNA (4/5)

❖ **Node Information Reply for DNS Name Collection**



Demonstration of DNSNA (5/5)

❖ DNS Dynamic Update

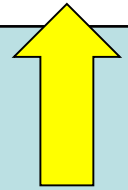


Gateway

```
Found zone name: cpsdns.com
The master is: ns.cpsdns.com
Sending update to 115.145.178.190#53
Outgoing update query:
;; ->>HEADER<<- opcode: UPDATE, status: NOERROR, id:  65476
;; flags:; ZONE: 1, PREREQ: 0, UPDATE: 1, ADDITIONAL: 1
;; UPDATE SECTION:
etype-meter-cc02.jubix-waemcc.powermeter.secter1.grid.cpsdns.com. 300 IN AAAA 20
01:be7f:0:190::11
```

```
Found zone name: cpsdns.com
The master is: ns.cpsdns.com
Sending update to 115.145.178.190#53
Outgoing update query:
;; ->>HEADER<<- opcode: UPDATE, status: NOERROR, id:  61610
;; flags:; ZONE: 1, PREREQ: 0, UPDATE: 1, ADDITIONAL: 1
;; UPDATE SECTION:
gtype-meter-cc14.jubix-wagmcc.powermeter.secter1.grid.cpsdns.com. 300 IN AAAA 20
01:be7f:0:190::12
```

❖ DNS Name Lookup



Client PC

```
> etype-meter-cc02.jubix-waemcc.powermeter.secter1.grid.cpsdns.com
Server:         115.145.178.190
Address:        115.145.178.190#53

etype-meter-cc02.jubix-waemcc.powermeter.secter1.grid.cpsdns.com        has AAAA address 2001:be7f:0:190::11
```

```
> gtype-meter-cc14.jubix-wagmcc.powermeter.secter1.grid.cpsdns.com
Server:         115.145.178.190
Address:        115.145.178.190#53

gtype-meter-cc14.jubix-wagmcc.powermeter.secter1.grid.cpsdns.com        has AAAA address 2001:be7f:0:190::12
```