

Distributed Systems

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Resource and Service Management

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Introduction

- Resource/ Service
 - An entity that is available in limited supply
 - Ex: memory, storage, DB connection, network connection, security token, IoT devices
 - 若此資源主要透過軟體API提供，則又稱為Service
- Roles
 - Resource user
 - Resource provider

Introduction

- Name
 - 一個參考，透過它，可以透過網路存取Resource or Service
 - 例: URI、URN
 - 廣義的name包含該項資源的屬性(attributes)
- 設置方式
 - 集中式
 - 問目錄(registry、directory)
 - Ex: DNS、LDAP → lightweight directory access protocol
 - 分散式
 - 同伴口耳相傳
 - Ex: mDNS、SSDP

simple service discovery protocol : basis
of discovery protocol of DPNP

Resource/ Service Discovery

- The core technology of resource/ service management
- user能即時得知一定範圍內的其它資源/服務相關資訊的機制，包含：
 - Presence
 - 目前是否存在於「此系統」
 - Description
 - Type: 能夠提供的功能類型
 - Access point: (網路) 位置
 - Location: (實體) 位置
 - Attributes: 可以描述此節點的資訊
 - Ex: type=printer, cost = 1 per page, location=201R

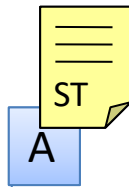
Common Characteristics of Discovery Protocols

- Presence Management *PA, a message or signal sent on a network to announce the availability of a device or service*
 - Presence announcement and capability advertisement
 - Evicting failed or left services
- Service Lookup
 - Match a “specification (template)” with “capabilities”
 - By type
 - By type, and then filter by attributes
 - By semantic approaches

服務發現機制的一般性模型

需要什麼能力？

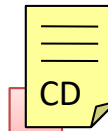
Service Template (Service Specification)



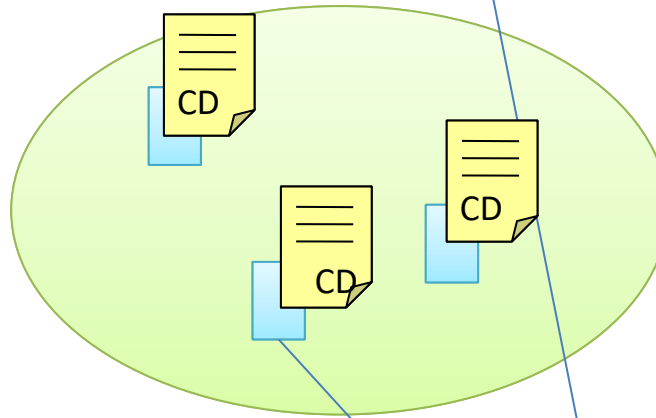
Client (Resource/
Service User)

有哪些能力？

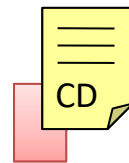
Capability Descriptor



Scope



Service (Resource/ Service Provider)



Service and attribute naming

uniform resource name (location independent)

○ Naming approach

● User friendly names

- 若不小心管理，可能會有名稱混淆或重複的問題
- Ex: TV, stereo, air conditioner, ...
- URL、URN亦屬於此類

Bluetooth Low Energy: wearables, sensors, etc

● Machine friendly names

- 使用者較難了解意義(需要透過額外機制或工具轉換)
- Ex: UUID (BLE採用UUID)

→ universally unique identifier

- 61C4D231-FE17-4AD1-B159-64F880FFC44E

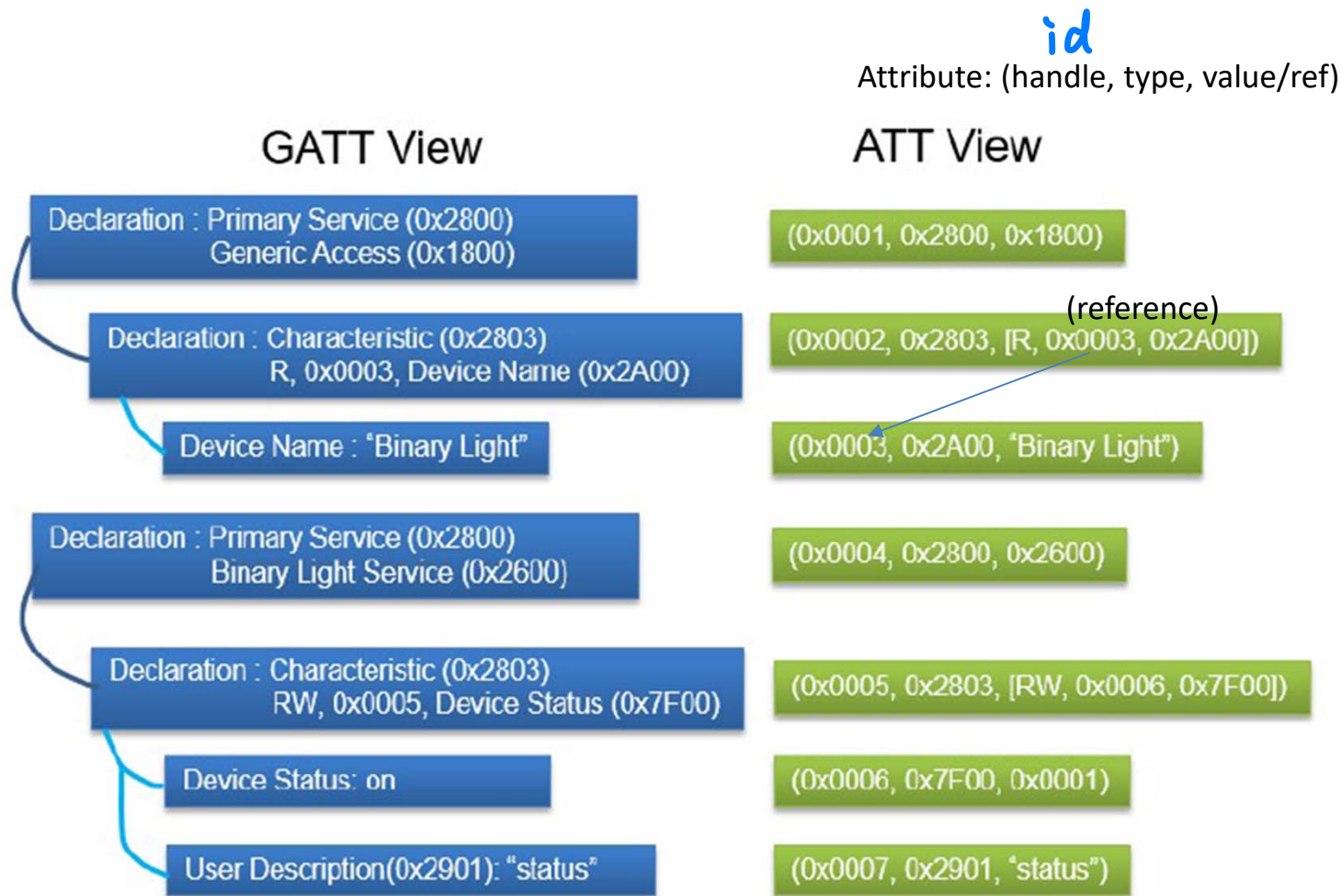
○ 網路資源有限

Service and attribute naming

- A client searches a service by a name and attributes
 - Template-based
 - 提供特定命名格式 (URN)
 - mDNS/DNS-SD: light._sub._http._tcp.local
 - UPnP: urn:schemas-upnp-org:device:BinaryLight:1
→ Universal Plug & Play
 - Template-based and predefined
 - 除命名格式，對於常用名稱也提供標準定義
 - BLE:以規格書定義了一系列16-bit 的代碼對應到不同的Attribute types
 - GATT (Generic Attribute Profile)
 - ATT (Attribute Protocol):

$a_k \in A, a_k = (i_k, \tau_k, v_k)$ Attribute: (handle, type, value/ref)

Bluetooth Capability Descriptor (CD)

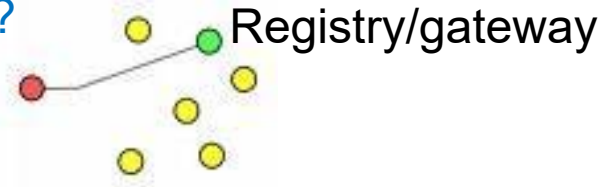


high level

low level

Initial communication method

加入群體時，如何讓大家認識？



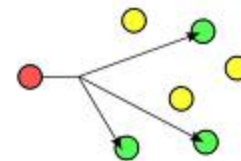
- Unicast

The most efficient, but need to configure network addresses with prior knowledge.

LAN

- Multicast

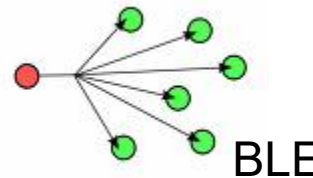
(Transport Layer)



UPnP, mDNS/DNS-SD

- Broadcast

(Link Layer)

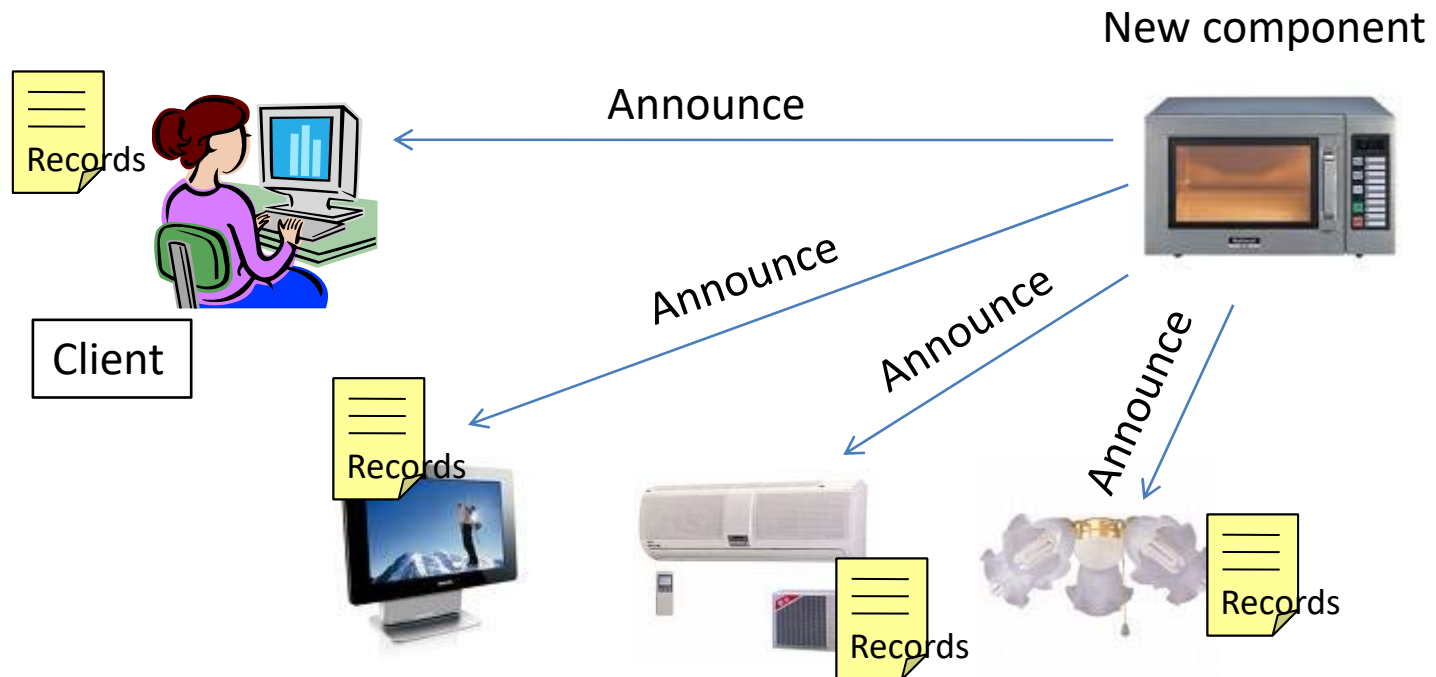


BLE

Discovery and registration

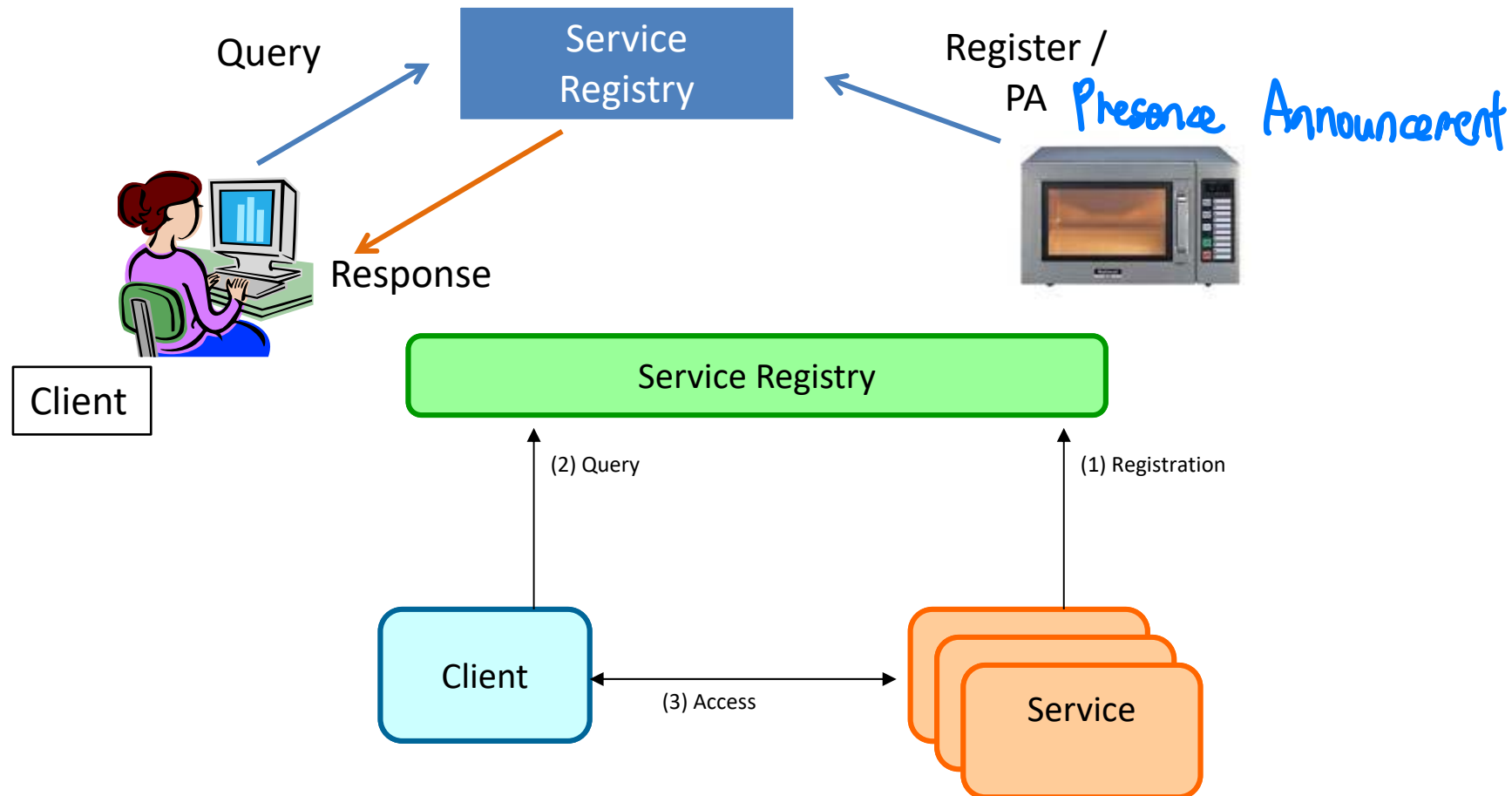
- **Announcement-based** Client要自己維護服務清單

Interested parties listen on a channel. When a service announces its availability and information, all parties hear the information.




- **Query-based** 服務清單由registry (directory)統一維護

A party receives an immediate response to a query and doesn't need to process unrelated announcements.



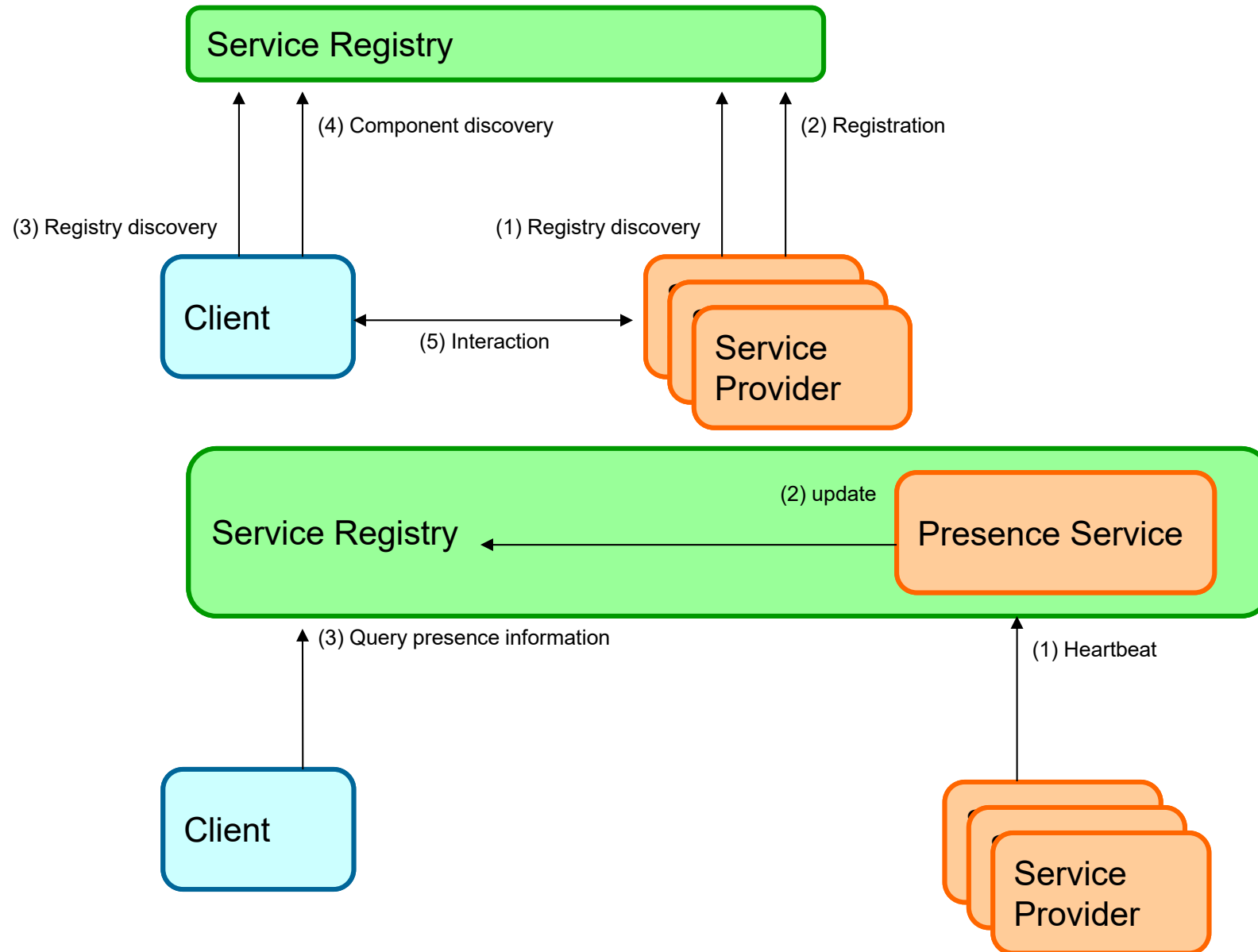
Discovery Infrastructure

- Directory-based
 - Has dedicated registries that maintain information and status of service components
 - Ex: CORBA, Web Services, Jini
- Non-directory-based
 - Rely on broadcasting or multicasting mechanisms
 - Ex: UPnP, P2P systems



A standard defined by Object Management Group (OMG) that facilitates communication of systems deployed on diverse platforms (OS, PL, H/W ...)

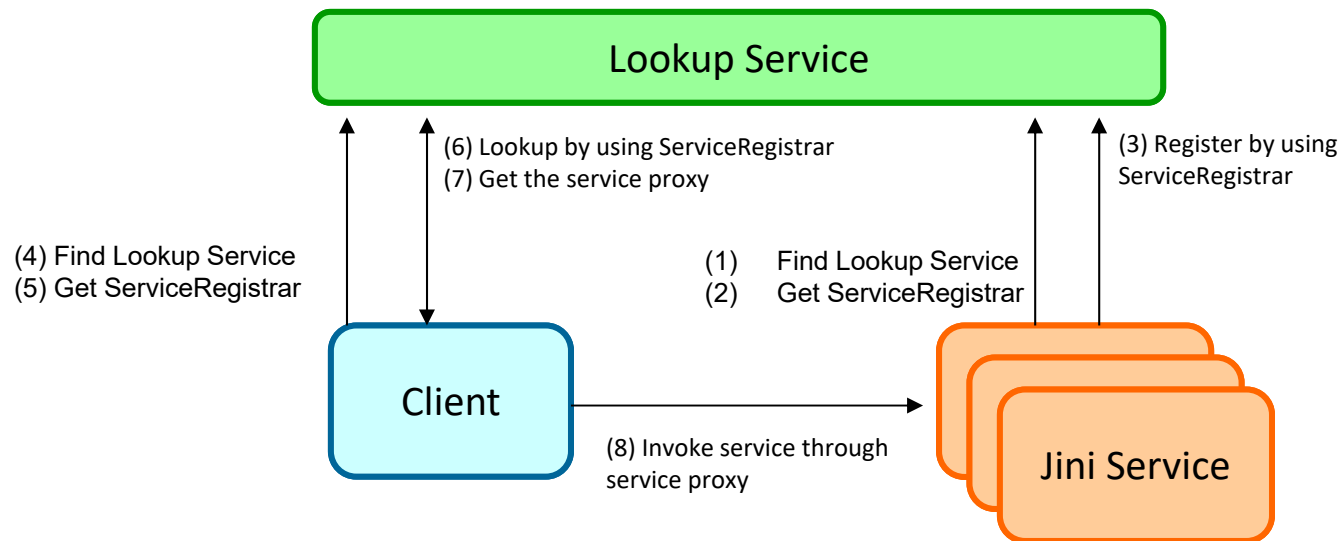
Directory-based



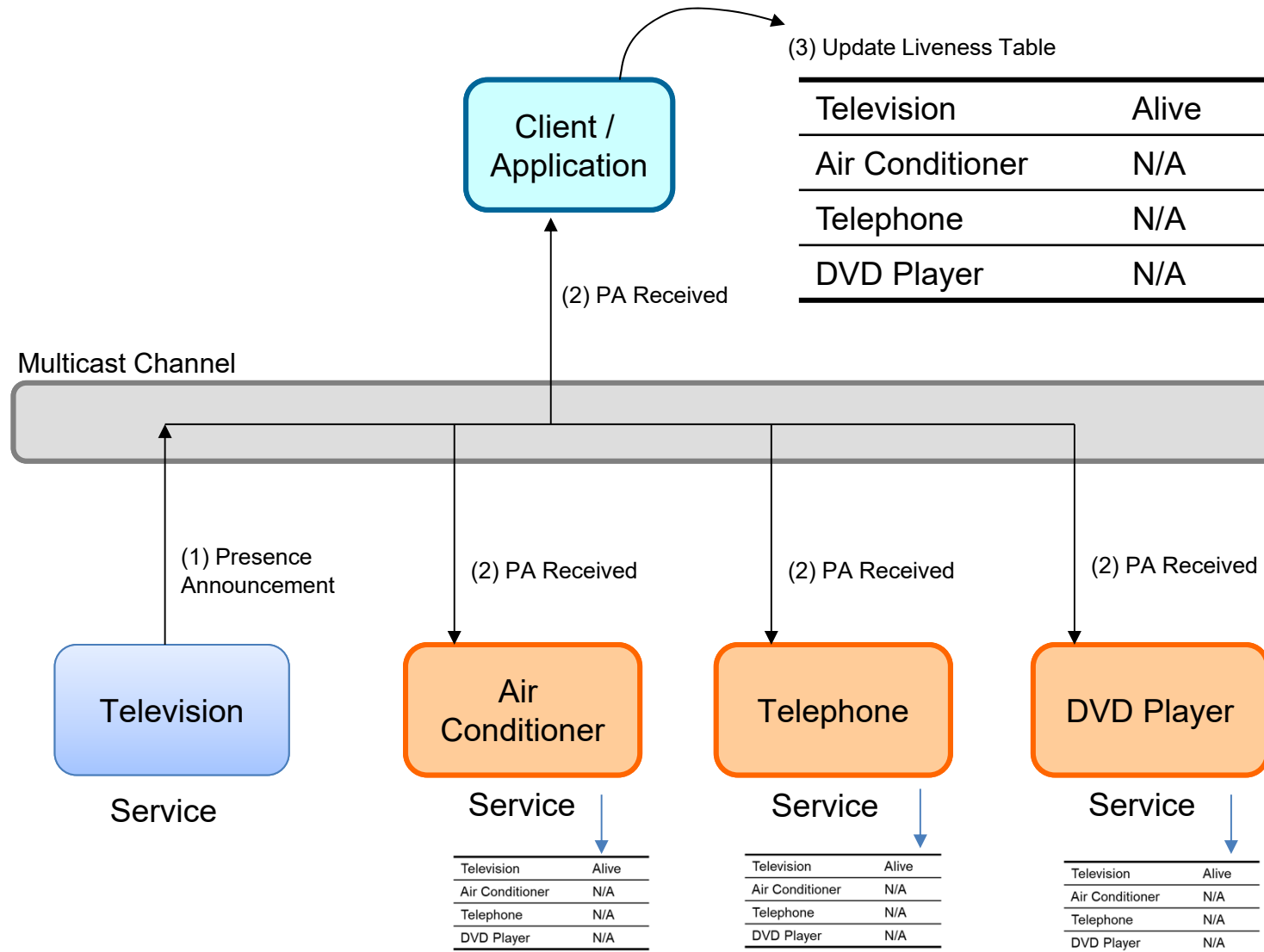
Case: Jini

<https://river.apache.org/>

- a network architecture for the construction of distributed systems in the form of modular co-operating services
- Originally developed by Sun Microsystems (1998)



Non-Directory-based



SSDP Announcement

http-like
message

NOTIFY * HTTP/1.1

simple service discovery protocol : basis
of discovery protocol of DPNP

NT: urn:schemas-upnp-org:device:DimmableLight:1

USN: uuid:ecd54de1-9008-4df5-b5bb-a0722612afdc::

urn:schemas-upnp-org:device:DimmableLight:1

NTS: ssdp:alive

SERVER: Windows NT/5.0, UPnP/1.0

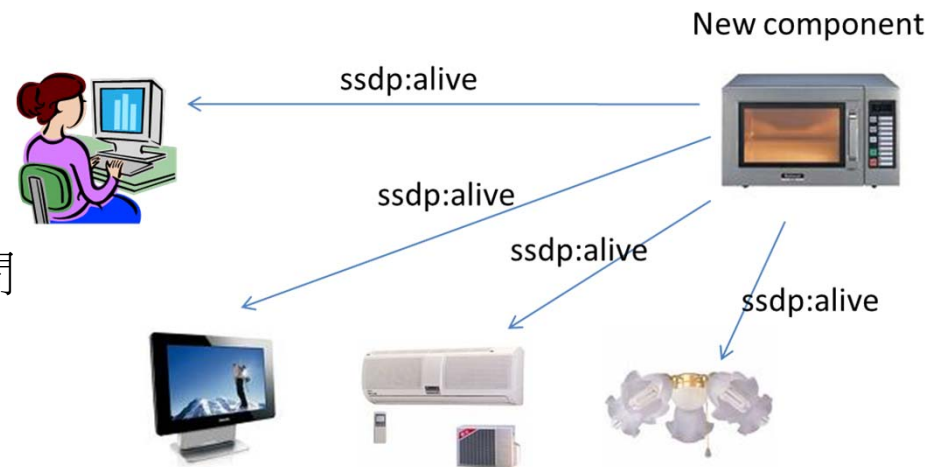
LOCATION: http://192.168.4.37:1810/

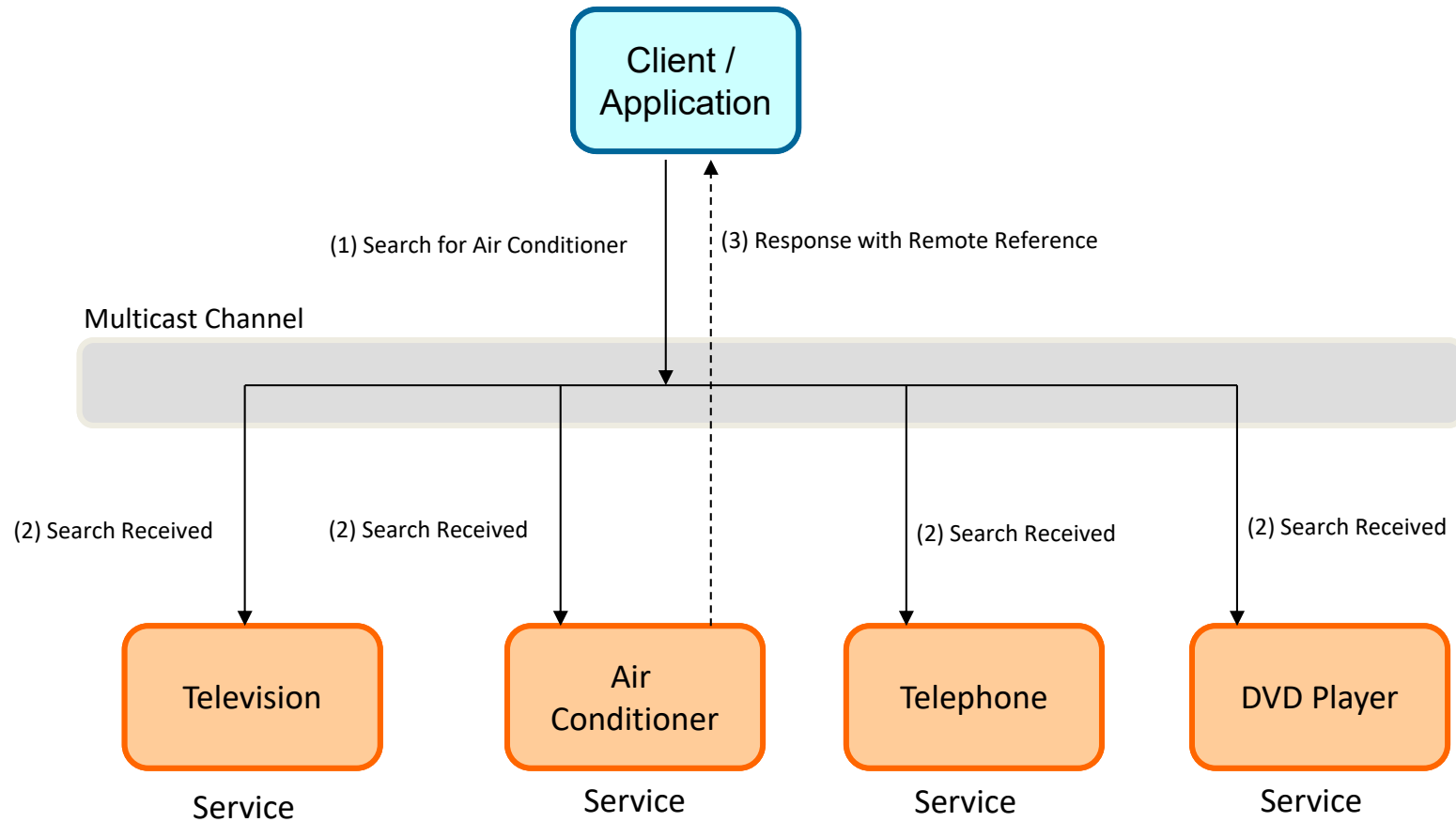
HOST: 239.255.255.250:1900 群播位址

CACHE-CONTROL: max-age=900 有效期間

Content-Length: 0

unique
sender
name





SSDP Query

M-SEARCH * HTTP/1.1

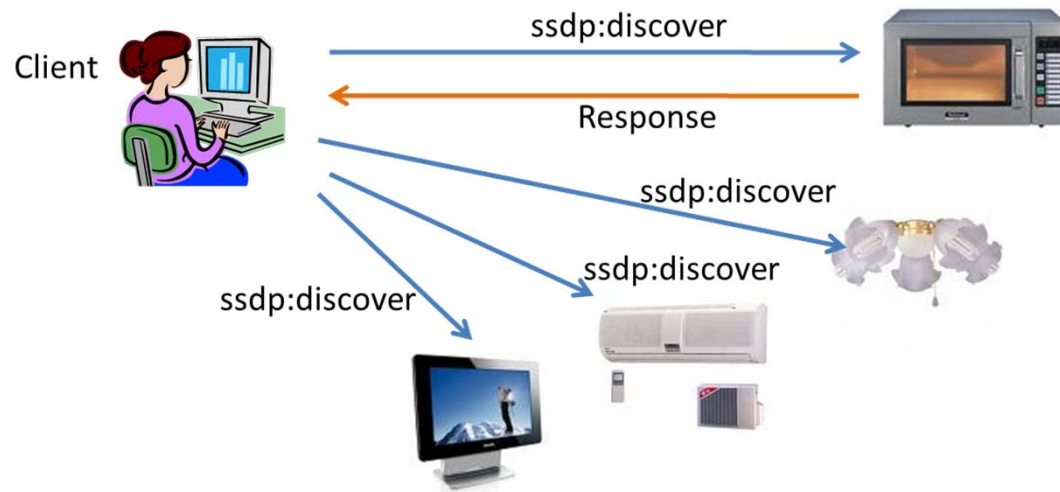
ST: urn:schemas-upnp-org:device:MediaRenderer:1 要搜尋的目標種類

MX: 10 最多等幾秒回應

MAN: "ssdp:discover"

HOST: 239.255.255.250:1900 群播位址

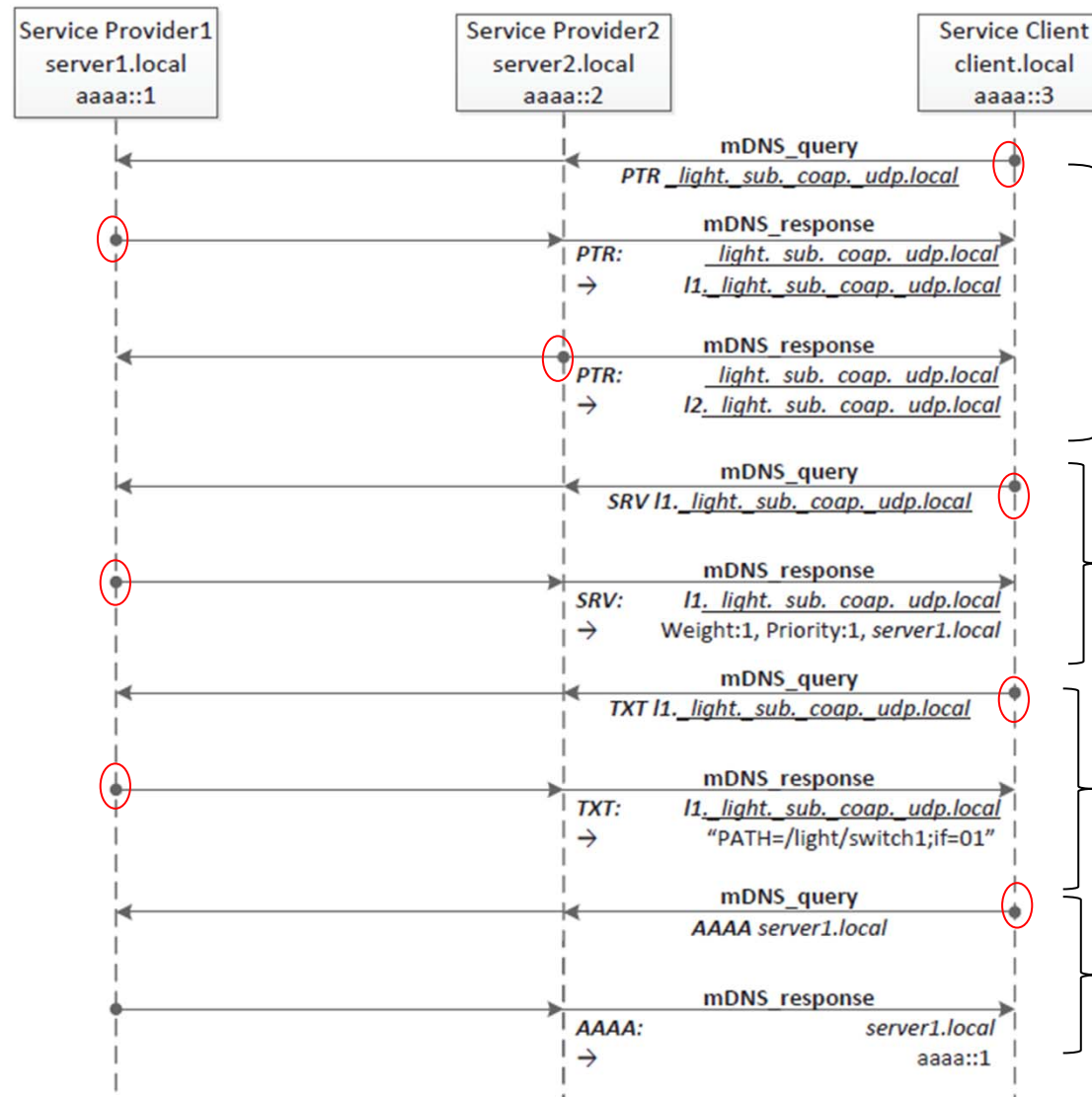
Content-Length: 0



Service Discovery

mDNS/DNS-SD

bonjour/zeroconf



* PTR: IP addr → domain name (reversed DNS lookup)
詢問有誰提供 Light服務

* SRV: identify the hostname & port number for specified servers
取得服務(port)資訊

取得附加(txt)資訊

取得IP

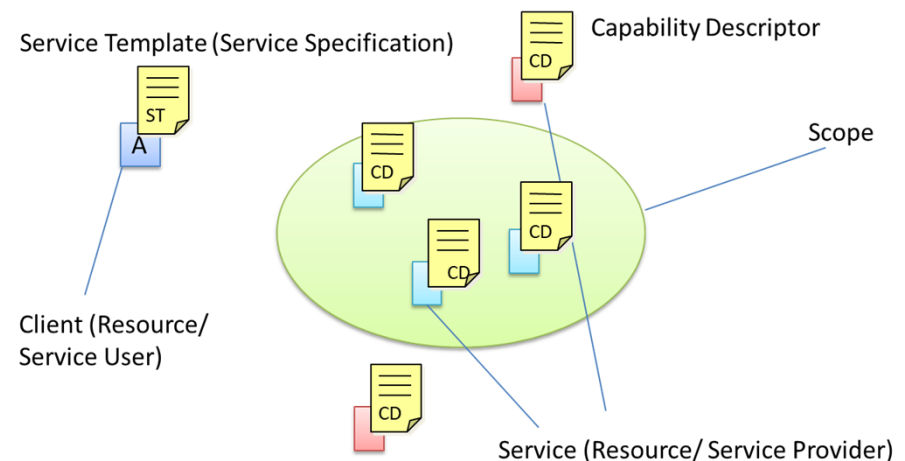
Discovery scope

- Network topology

Ex: LAN

- User role

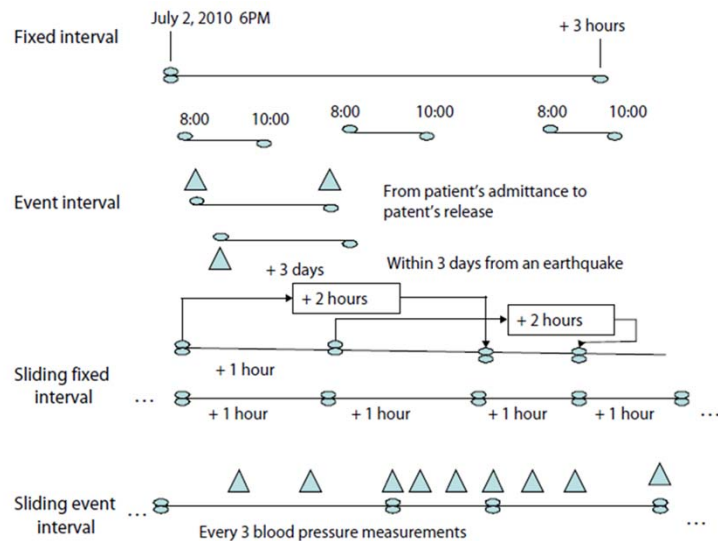
Lets users control the target domain, but it requires prior knowledge of the target service and its domain



○ Context

Temporal, spatial, and user activity information can also help define the discovery scope

和context無關的就不加以搜尋



以絕對時間區分

以事件發生區分

以相對時間區分

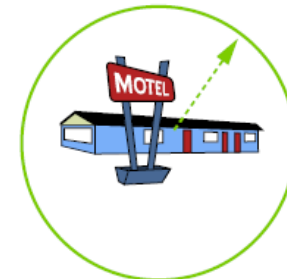
以事件發生次數區分

Fixed location



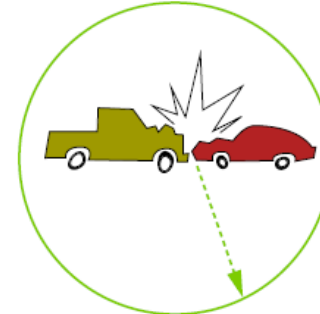
Within the house

Entity distance location



Within 2 km from the motel

Event distance location



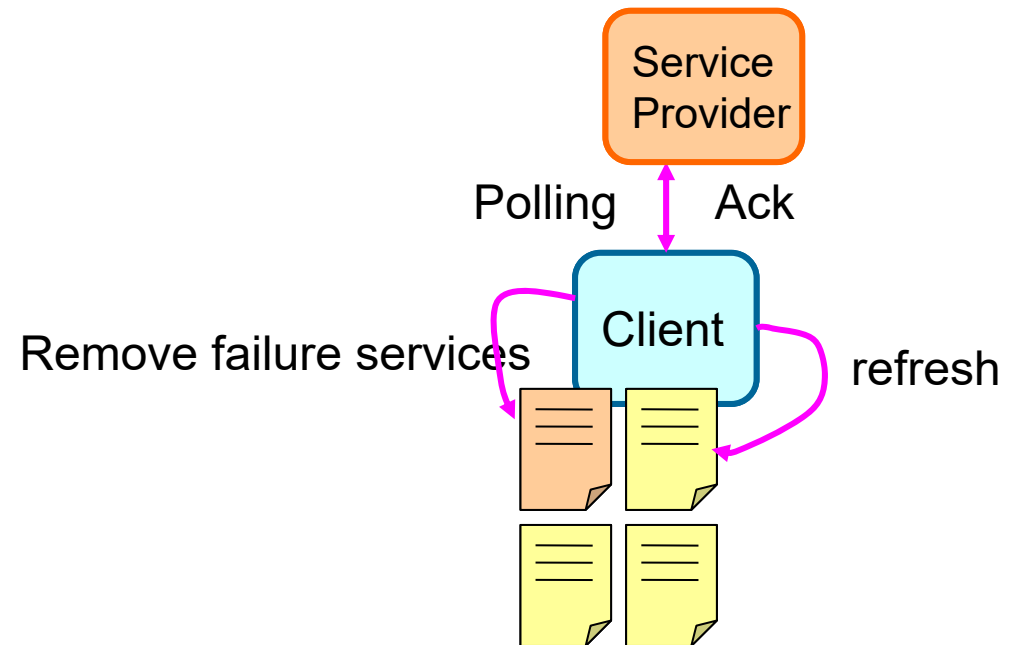
Within 10 km from the accident

Status Inquiry

- **Polling**

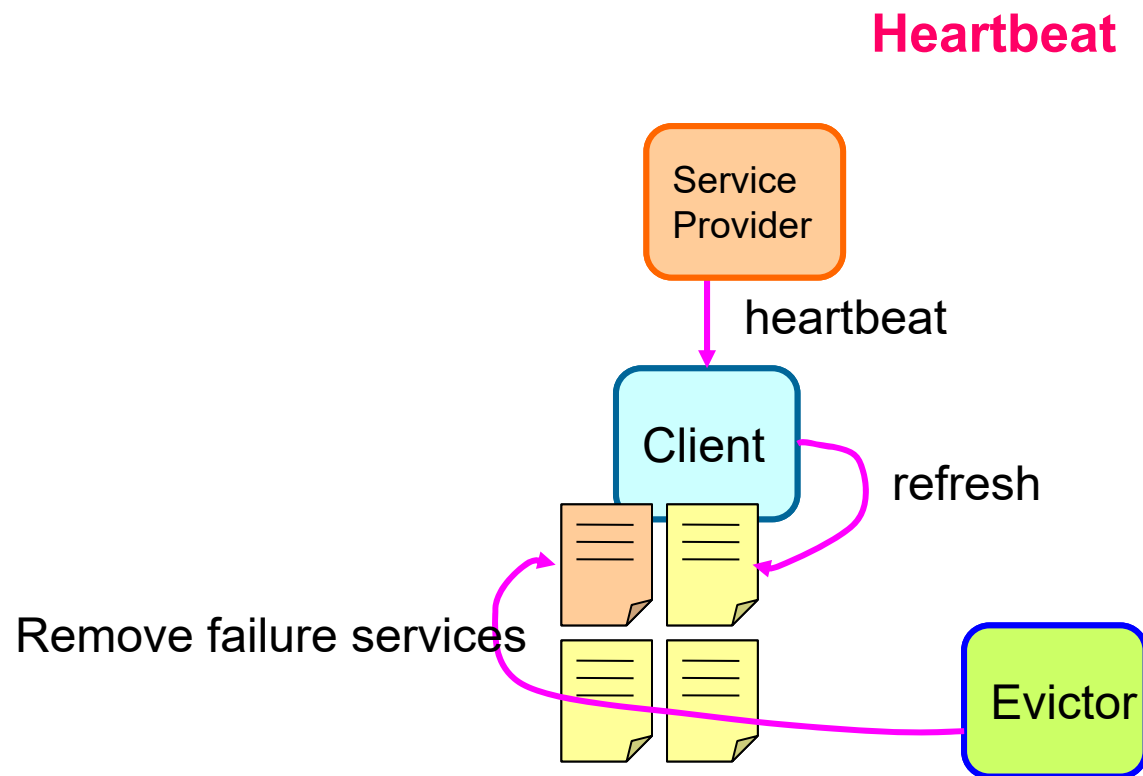
A client can keep up with a service's events or status by polling it periodically.

(Case: SSDP M-Search)

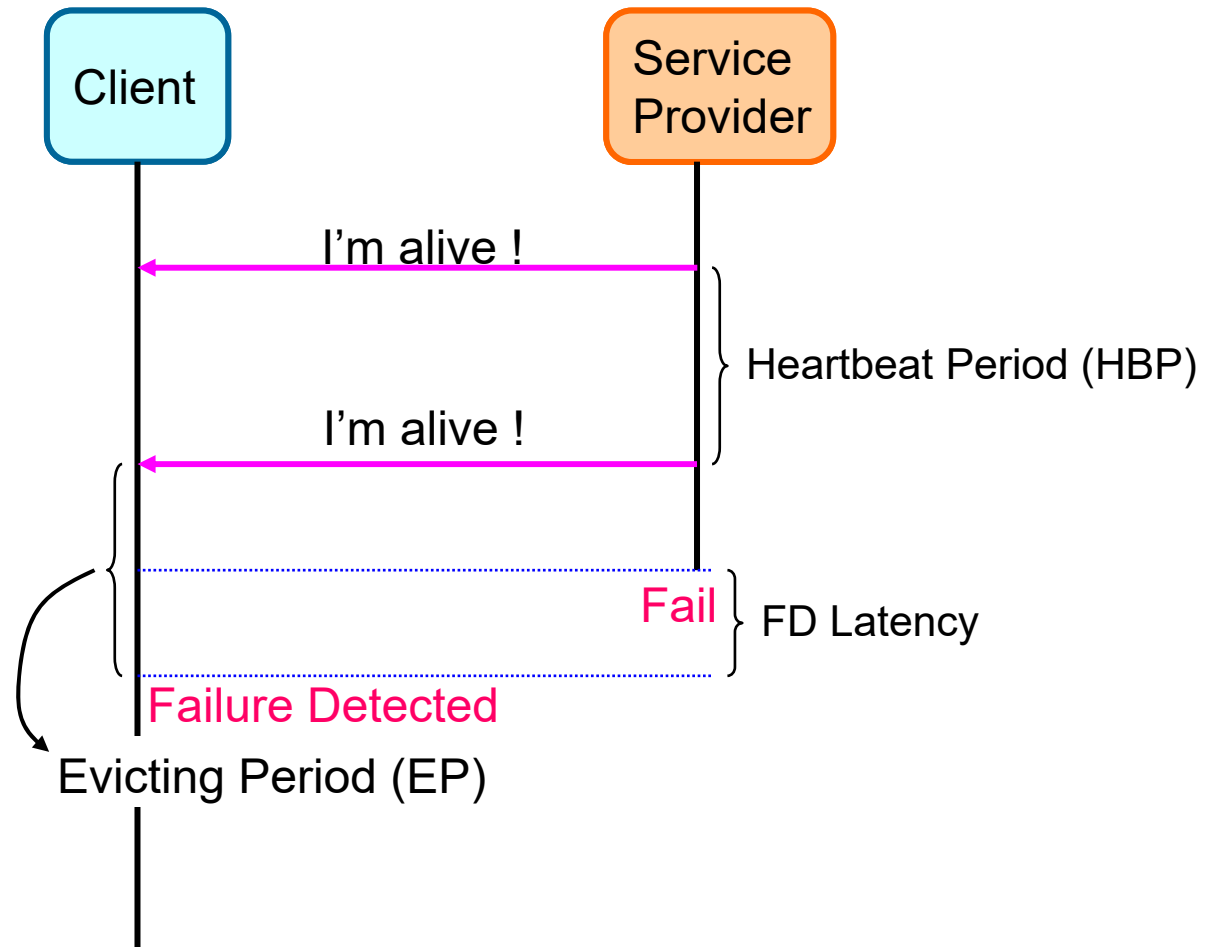


- **Notification (Heartbeat)**

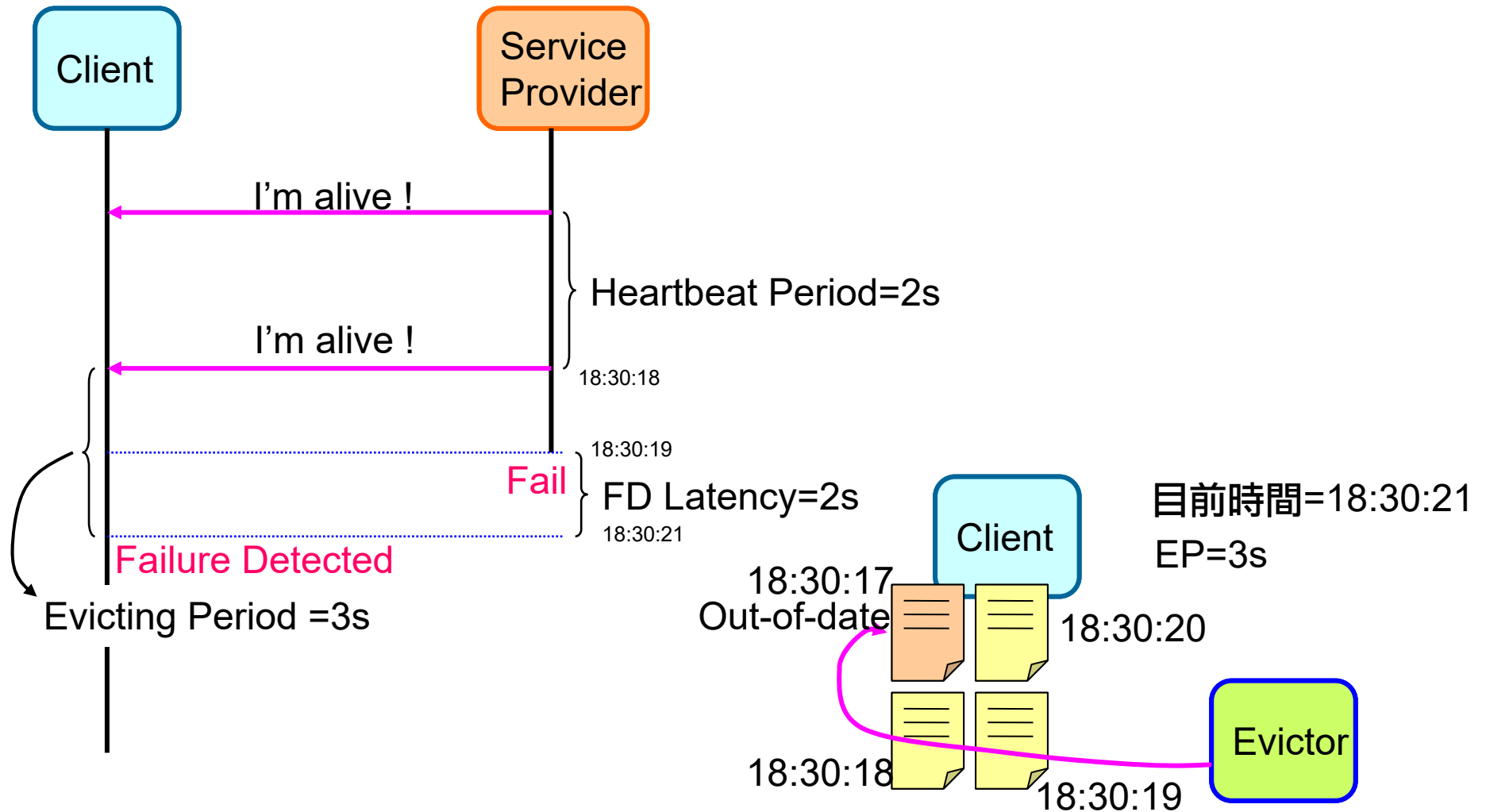
(Case: SSDP Notify)



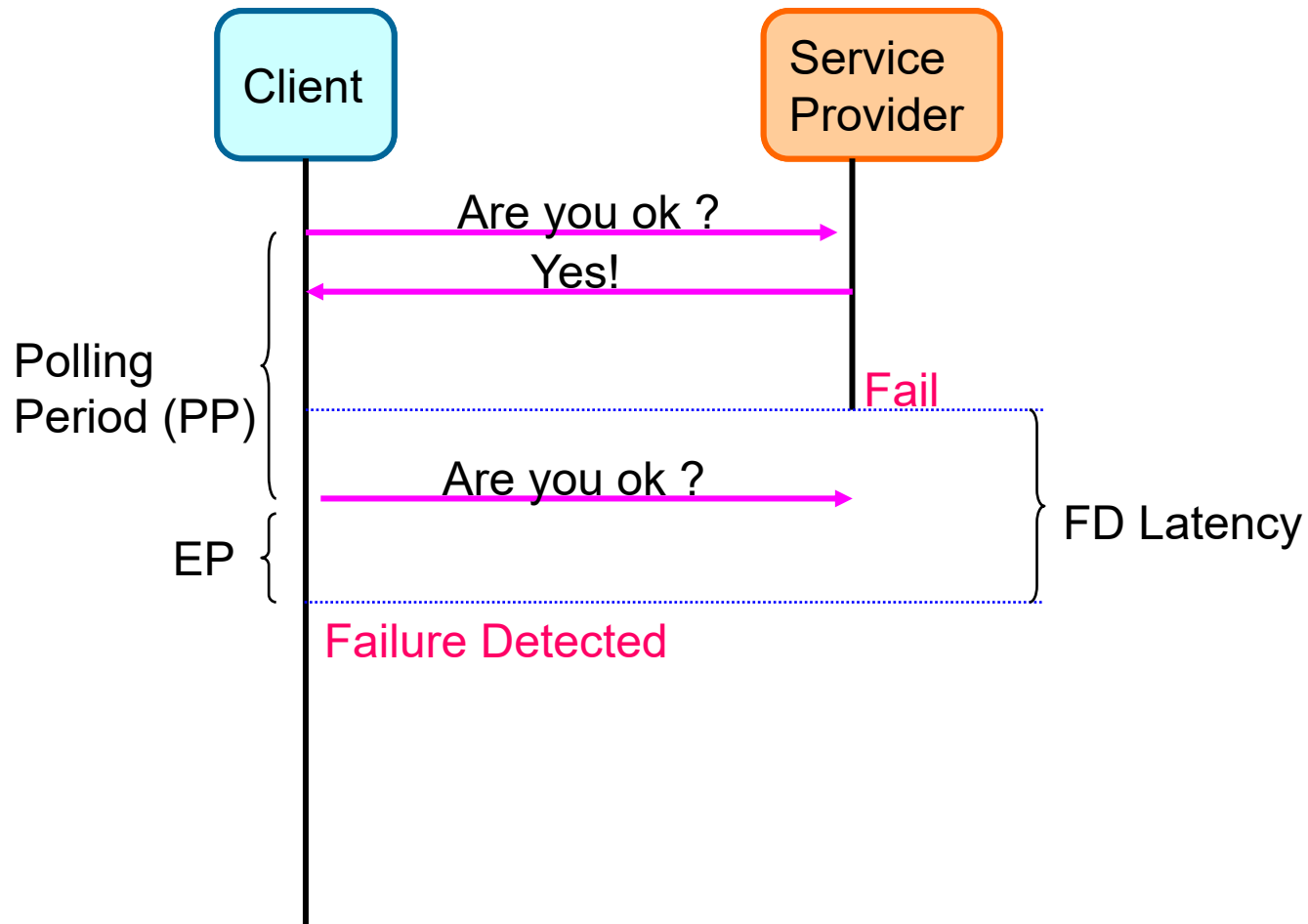
Heartbeat



Example



Polling



Polling雖然一次要二個network access，但可以由Client自行控制頻率

FD Latency is Significant!

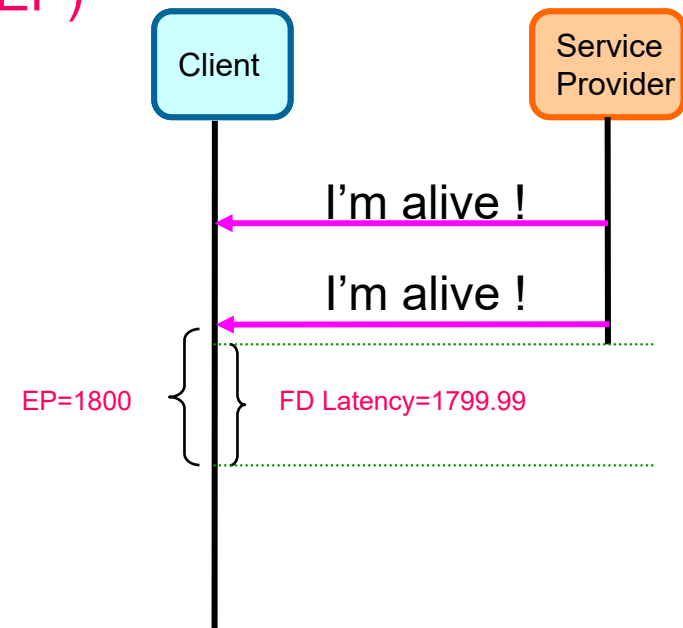
- The FD Latencies of existing Discovery Protocols are high :

Example:

For Heartbeat, FD Latency < Eviction Period (EP)

- SSDP / UPnP: EP=1800s (0.5 hrs)
- Rendezvous: EP=7200s (2hrs)
- SLP: EP=64800s (18hrs)
- Jini: EP=120s (2min)

Service Location
Protocol



The Trade-Offs

- If the EP or PP too short may cause:
 - Network flooding
 - Heavy loading of services

