Application Level Control of Ports in a Service Provider NAT environment

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Port Control Protocol

- Service Provider NATs have problems:
  - Lack of control of port reservation /port forwarding
  - Some legacy applications will break
- A+P was one approach to address those issues
- PCP is another approach to give back control to the customers via their applications.
  - Enable applications to dynamically negotiate ports with the service provider NAT
  - Provide some level of backward compatibility with existing APIs (UPnP/NAT-PMP)

Port-Forwarding APIs

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Model

- No change to IP model:
  - A full IP address is still assigned to every interface, including on NATs
- App/framework wants to learn the (full) IP address of *another machine's* (the NAT's) interface, and a port that machine will forward
  - Can't be done using normal IP address APIs without changing the IP model
  - App/framework can then advertise in app-specific manner (SRV record, email, DHT, etc.)
- Hence this is **opt-in** for an app or framework

Two separate app scenarios

- Manage static port mapping
  - Management style application wants to configure a given external port to be permanently forwarded to a given port on a given machine
- Manage dynamic port mapping
  - Runtime application wants to get an external port allocated and forwarded to its port on its machine for some duration

NATUPnP Library (Windows)

```
NATUPNPLib.UPnPNATClass upnpnat = new
  NATUPNPLib.UPnPNATClass();
NATUPNPLib.IStaticPortMappingCollection mappings
  = upnpnat.StaticPortMappingCollection;

err = mappings.Add(8080,    // External port
          "TCP",            // Protocol
          80,               // Internal port
          "192.168.1.100", // Internal IP
          true,             // Enabled
          "Local Web Server"); // Description
```

- External port=0 means wildcard, but many NATs don't support

NATUPnP API Observations

- Either requested port is allocated or call fails
- Internal IP parameter allows for management applications
- Only supports static port mapping (no lifetime)
  - UPnP protocol allows lifetimes, but NATs may not support them
- Interface can be determined based on internal IP parameter

DNSServiceNAT (Apple)

```
DNSServiceRef sdRef;

err = DNSServiceNATPortMappingCreate(&sdRef, 0,
  0,                          // ifIndex or 0
  kDNSServiceProtocol_TCP,    // Protocol
  htons(80),                  // Internal port
  htons(8080),                // External port
  3600,                       // Lifetime
  callBack, NULL);
```

- External port=0 means wildcard

DNSServiceNAT Observations

- Lifetime parameter allows for runtime applications
- External port is just a preference, it may succeed and return something else
- Lack of internal IP parameter means not designed for arbitrary management app

Port Control Protocol

draft-wing-softwire-port-control-protocol-01

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Port Control Protocol

- Need to offer port forwarding capability when Service Provider NAT are deployed
  - Ability to offer similar service features as per current CPE model
- Need to delegate port numbers to requesting applications/hosts to avoid enforcing ALGs at the Provider NAT
  - Overall performance of the Provider NAT not altered

PCP Requirements

- Support Large Scale NATs
  - Spanning many subscribers
- Allow subscriber apps to open ports
- IPv6
- Simple, lightweight
  - Application, proxying in CPE, and server
- Discover and control LSN
  - Without interfering with intermediate infrastructure

Why Not My Favorite Protocol?
(MIDCOM, UPnP IGD, NAT-PMP, DHCP …)

- None meet all requirements

PCP Applicability

- IPv4 address sharing
  - No NAT44 (fixed port range)
  - Stateful NAT44 (e.g., **DS-Lite**, LSN)
  - Stateless NAT64/NAT46
  - Stateful NAT64/NAT46

- IPv6 Simple CPE Security

PCP Basics

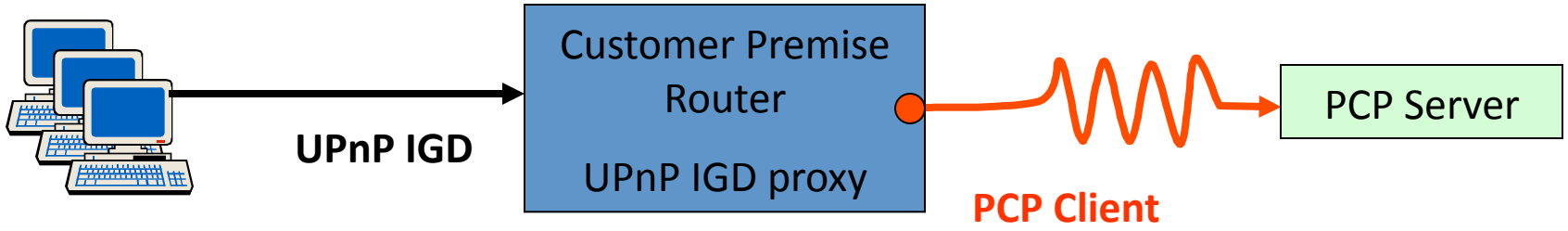
- Lightweight
  - Designed for deployment at large scale
  - Does not require heavy treatment at the Server side
    - Quick convergent Request/answer model
  - No permanent sessions are required to be maintained between the Client and the Server
- A subscriber can only open pinholes for his own devices
  - PCP isn't needed in every internal server
  - E.g., Customer Premise router can open pinhole for webcam or TiVo

PCP and IPv6

- NAT64
  - Open ports for incoming IPv4 traffic
    - E.g., IPv6 HTTP server in the home accessed from IPv4 Internet
- draft-ietf-v6ops-cpe-simple-security-09
  - Open pinholes in IPv6 CPE

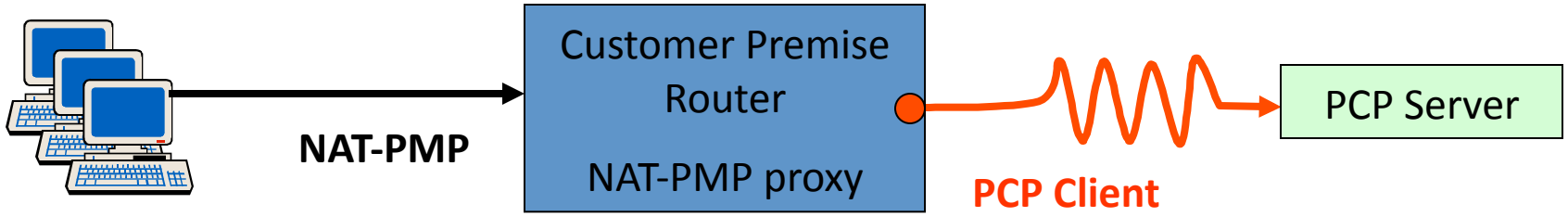
Client Models

PCP Client Model: UPnP IGD Proxy



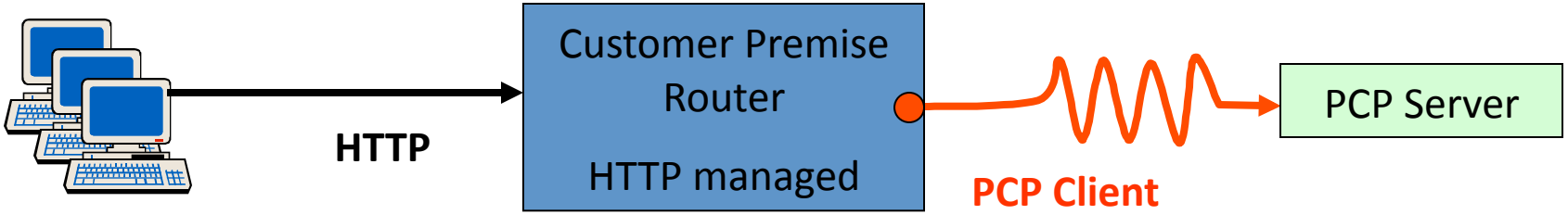
- Proxies UPnP IGD to PCP
- Provides compatibility for UPnP IGD
- Applications which want specific port will likely get an error
  - Can't help that

PCP Client Model: NAT-PMP Proxy



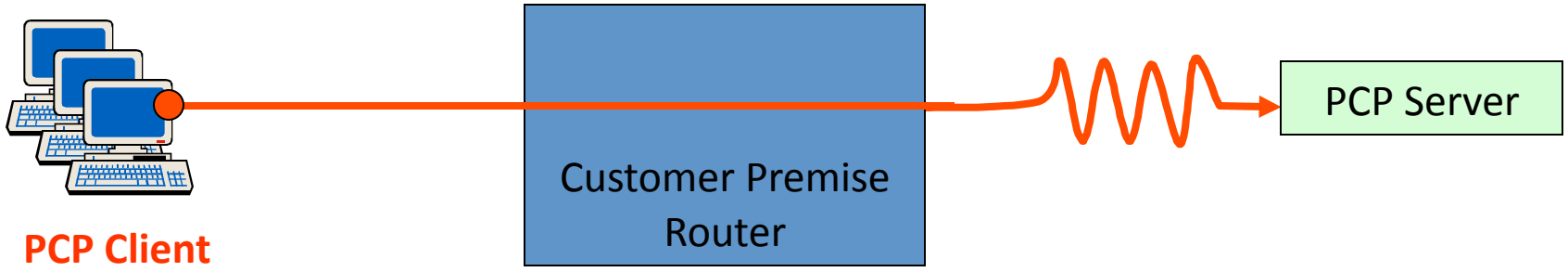
- Proxies NAT-PMP to PCP
- Provides compatibility for UPnP IGD
- No loss of semantics

PCP Client Model: HTTP



- Subscriber manages their own port forwarding
  - Similar to http://192.168.1.1, login as “admin”
  - Instructions at http://www.portforward.com
- Not for “Grandma”

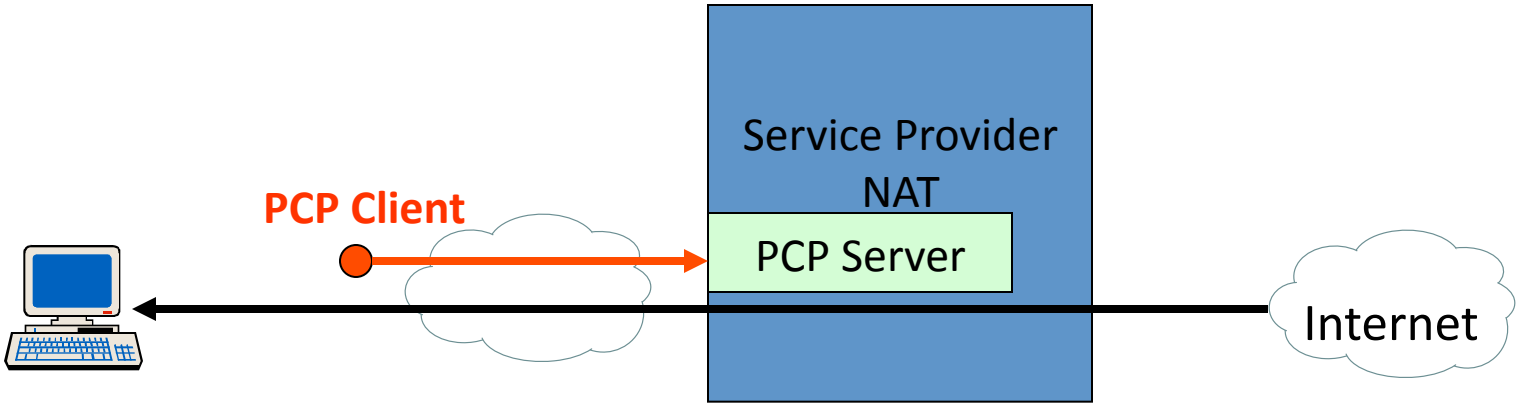
PCP Client Model: PCP on host



- Application (or OS) implements PCP client
- Customer premise router does nothing
  - Does not proxy PCP
- draft-ietf-v6ops-cpe-simple-security

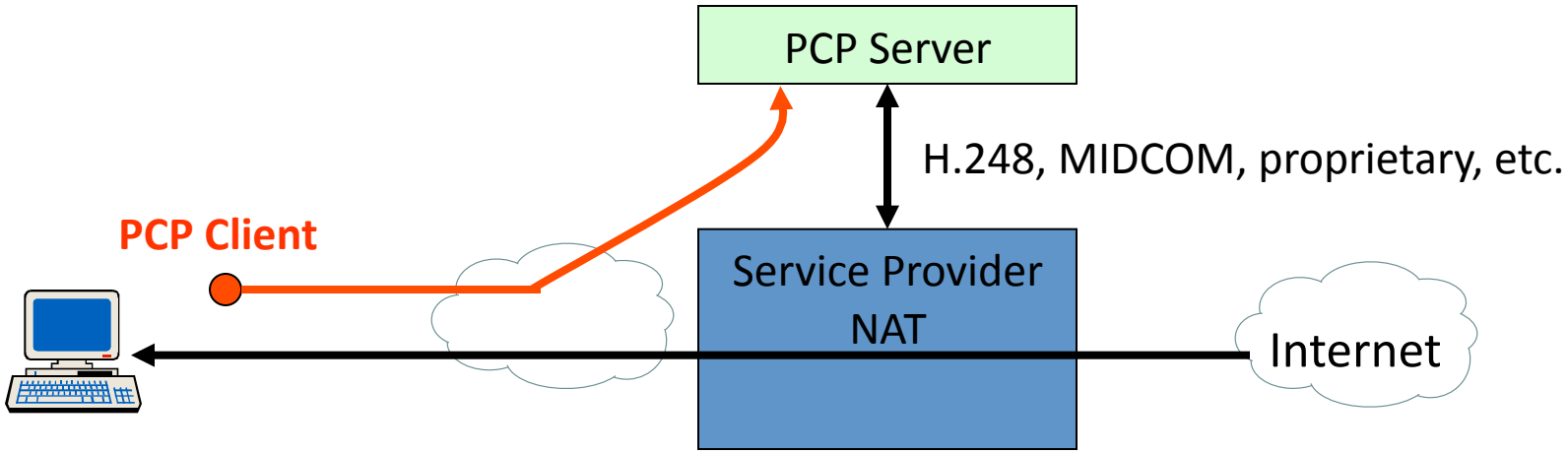
Server Models

PCP Server Model: Embedded



- PCP Server embedded in Service Provider's NAT
- Similar to UPnP IGD, NAT-PMP

PCP Server Model: Separate



- PCP Server is outside of the NAT
- Allows existing NAT control protocol

Questions

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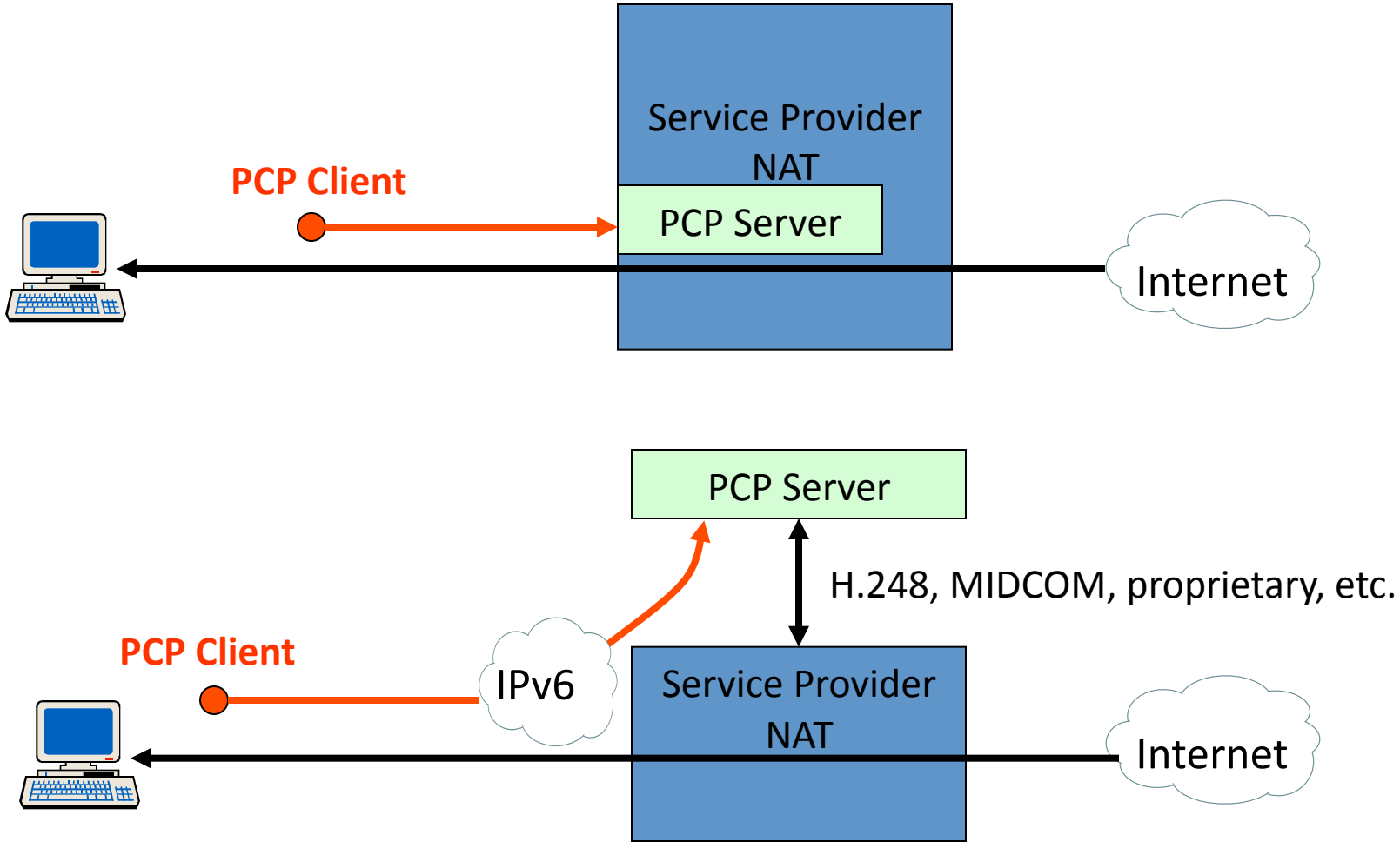
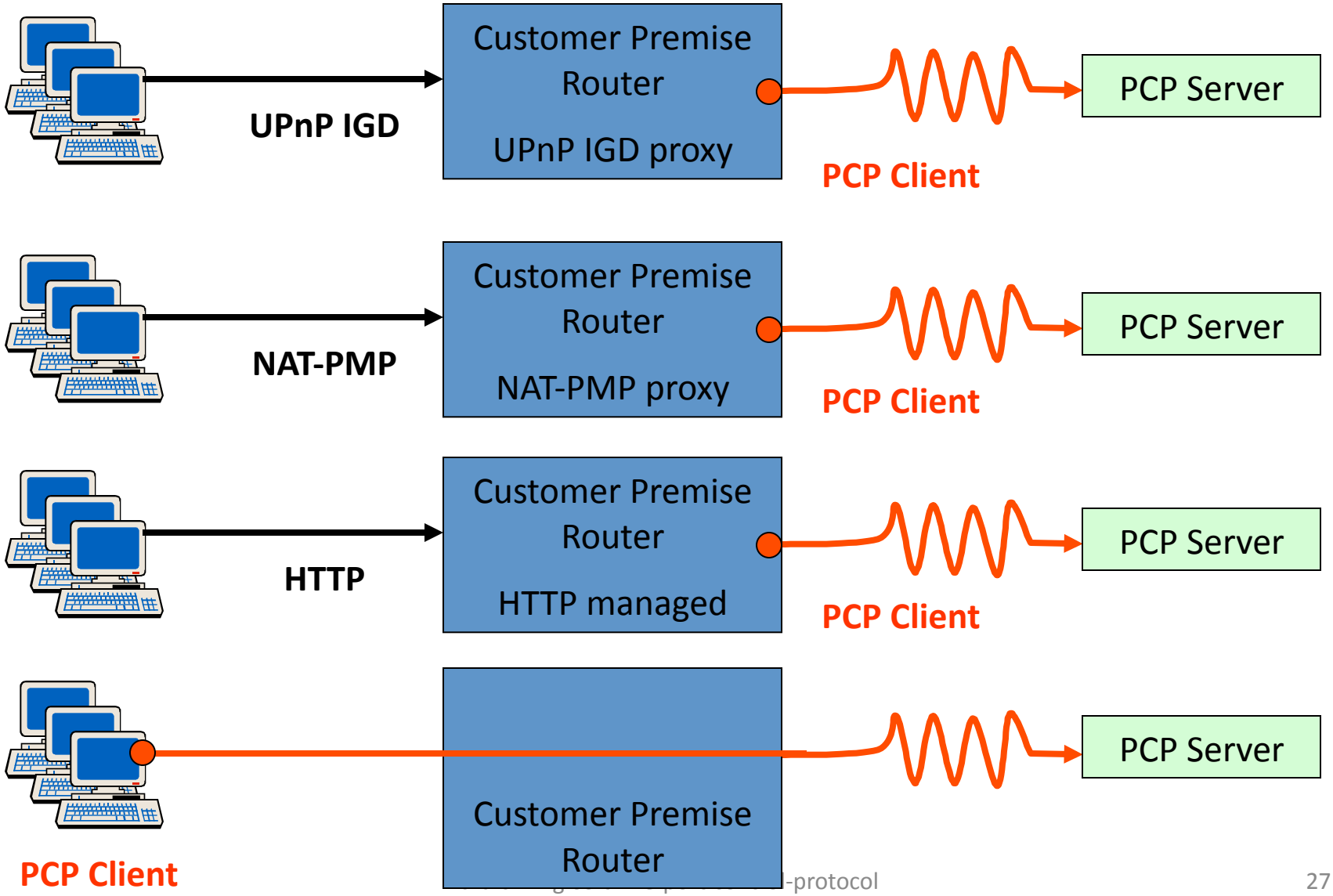
PCP Server Models



PCP Client Models



Mapping APIs/protocols to PCP

- Apps shouldn't have to know which case they're in
- DNSServiceNAT API / NAT-PMP protocol maps directly
- NATUPnP (v1) API / UPnP-IGD protocol more complicated
  - It can be done successfully, but it's kludgy