Tunnels

"Dr." Mark Tunnel^Wtownsley, Cisco Fellow

We build them…

When and where we think we need them for specific purposes

What goes in should come out..

Tunnels act like the layer below that which they are carrying

Often not perfectly, but "good enough" for a specific purpose

IP tunnels act like Data Link Layers

They provide us a Layer of Indirection

All problems in computer science can be solved by another level of indirection...

...except for the problem of too many levels of indirection
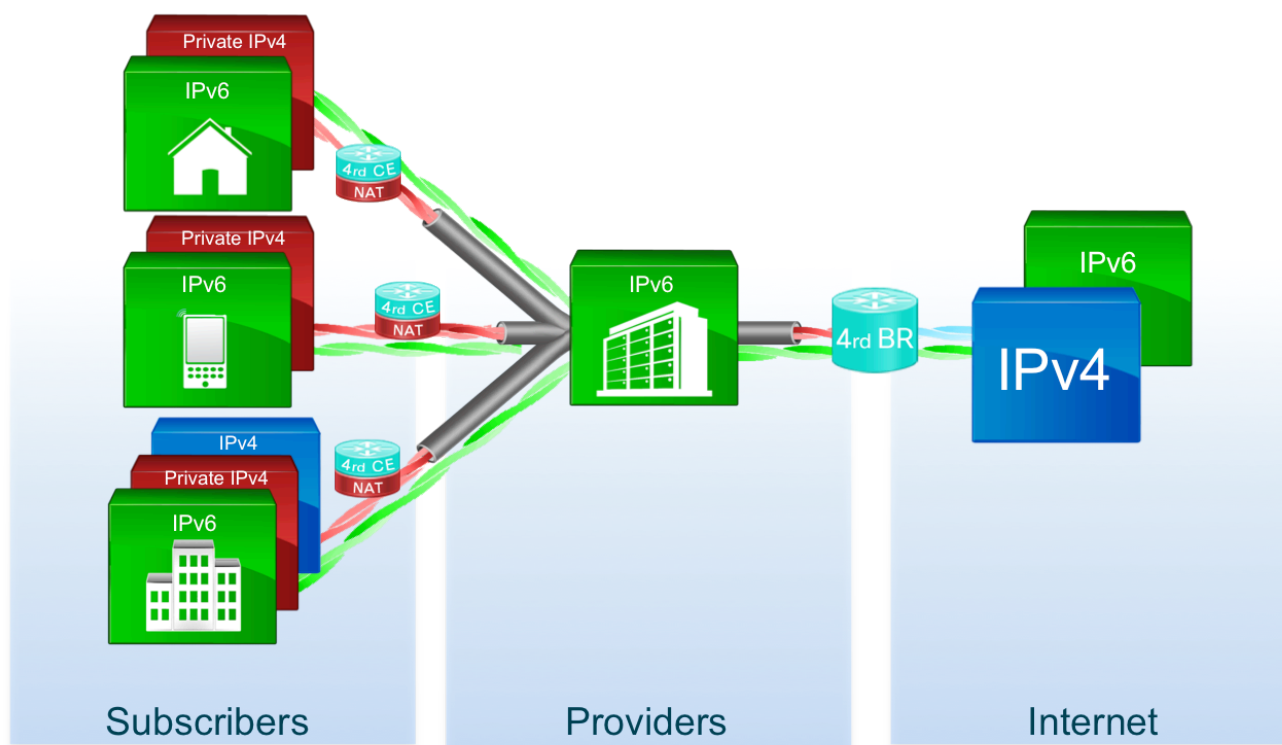
- David Wheeler
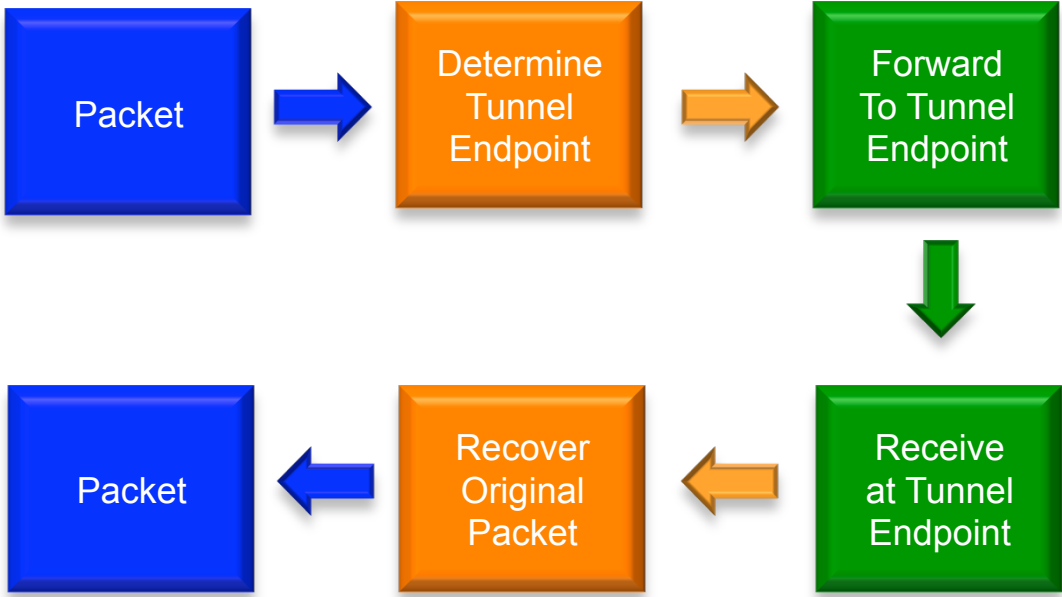
They have a
wide variety
of uses…

For the specific case of IPv6 Transition

- While incompatible on the wire, IPv4 and IPv6 are both still "philosophically" IP

Subscribers   Providers   Internet

Generic Tunneling Architecture
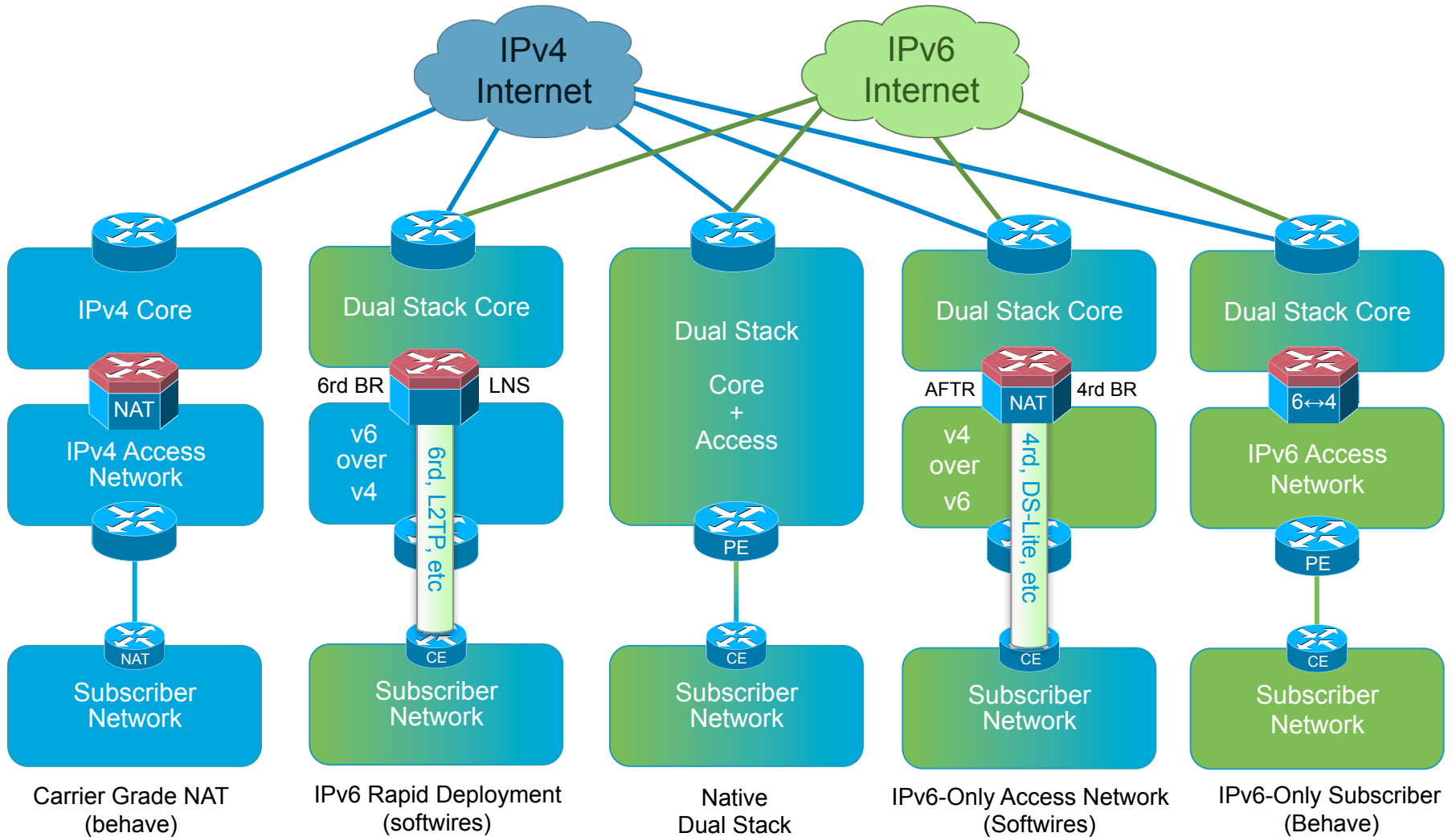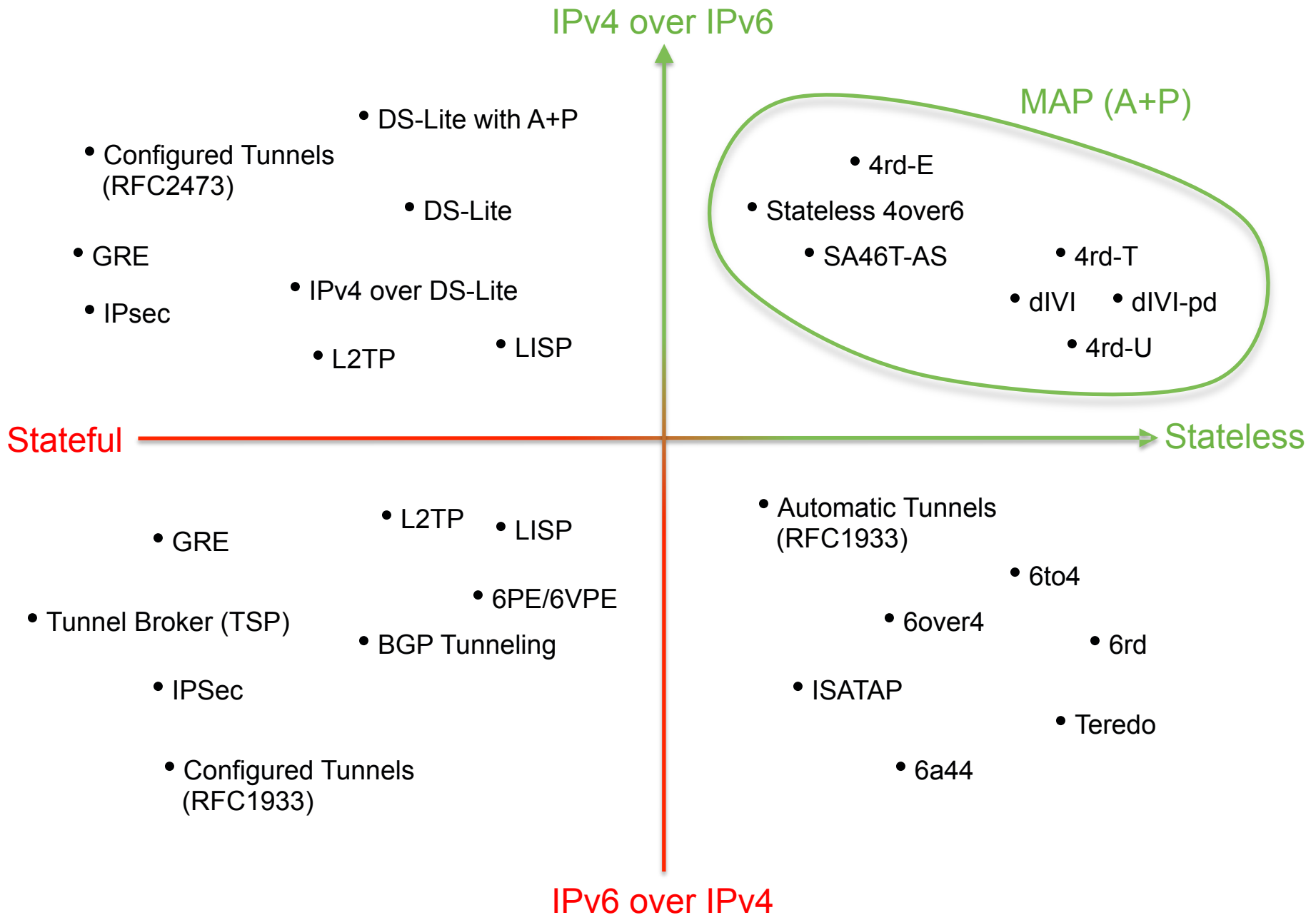
IP Tunneling Architecture

IP Packet → MAP → ENCAP

- **MAP**
  Stateful or
  Stateless

- **ENCAP**
  IPv6 over IPv4 or
  IPv4 over IPv6

IP Network Transitional Technologies

IPv4 Internet

IPv6 Internet

IPv4 Core

NAT

IPv4 Access Network

NAT

Subscriber Network

Carrier Grade NAT (behave)

Dual Stack Core

6rd BR — LNS

v6 over v4

6rd, L2TP, etc

CE

Subscriber Network

IPv6 Rapid Deployment (softwires)

Dual Stack

Core + Access

PE

CE

Subscriber Network

Native Dual Stack

Dual Stack Core

AFTR — NAT — 4rd BR

v4 over v6

4rd, DS-Lite, etc

CE

Subscriber Network

IPv6-Only Access Network (Softwires)

Dual Stack Core

6↔4

IPv6 Access Network

PE

CE

Subscriber Network

IPv6-Only Subscriber (Behave)

IPv4 over IPv6

- DS-Lite with A+P
- Configured Tunnels (RFC2473)
- DS-Lite
- GRE
- IPv4 over DS-Lite
- IPsec
- L2TP
- LISP

MAP (A+P)
- 4rd-E
- Stateless 4over6
- SA46T-AS
- 4rd-T
- dIVI
- dIVI-pd
- 4rd-U

Stateful ————————————————→ **Stateless**

- L2TP
- LISP
- Automatic Tunnels (RFC1933)
- GRE
- 6to4
- 6PE/6VPE
- 6over4
- Tunnel Broker (TSP)
- 6rd
- BGP Tunneling
- IPSec
- ISATAP
- Teredo
- Configured Tunnels (RFC1933)
- 6a44

IPv6 over IPv4

Thank you.

CISCO

Stateful vs. Stateless Tunneling

- "Stateful Tunneling" (e.g. L2TP)

    Dynamic or "per-tunnel" information must be distributed throughout tunnel endpoints

    Mapping function based on synchronized state built and destroyed on demand by tunneling system

    Scale is typically proportional to the amount of traffic and number of tunnel endpoints

    Control protocol, keepalives, etc. needed between endpoints

    Does more than "just tunnel"

    IPv4 and IPv6 addressing remain independent

- "Stateless Tunneling" (e.g. 6rd)

    A single common configuration must be distributed to all tunnel endpoints

    Mapping function is based on an algorithmic mapping from existing state and common config

    Scale is proportional only to the amount of traffic (point to multipoint)

    No control protocol needed between endpoints (aside of troubleshooting)

    Very focused on one specific goal

    IPv4 and IPv6 addressing are coupled via algorithmic mapping

What is a Tunnel?

- Something we create

  One reason there are so many kinds of tunnels is that they only have to interoperate between the tunnel endpoints we care about to be effective

- Provides a layer of indirection

  Which is the solution to all problems in computer science, except those brought on by the indirection

- Emulates a link-layer

  Often not perfectly, but "good enough" for a specific purpose – e.g., "Pseudowire"

- Tunnels are used for many, many, specific purposes

  <Insert LISP or MPLS use-case list here>

- For IPv6 transition, we essentially want a simple adaptation function between IPv4 and IPv6

  While incompatible on the wire, at least IPv4 and IPv6 are *similar* enough that the tunneling should be simple….