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Internet Exchange Points Benefits & Requirements

3rd Caribbean Internet Governance Forum

Wednesday, August 15, 2007

Curaçao, Netherlands Antilles

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Research Director

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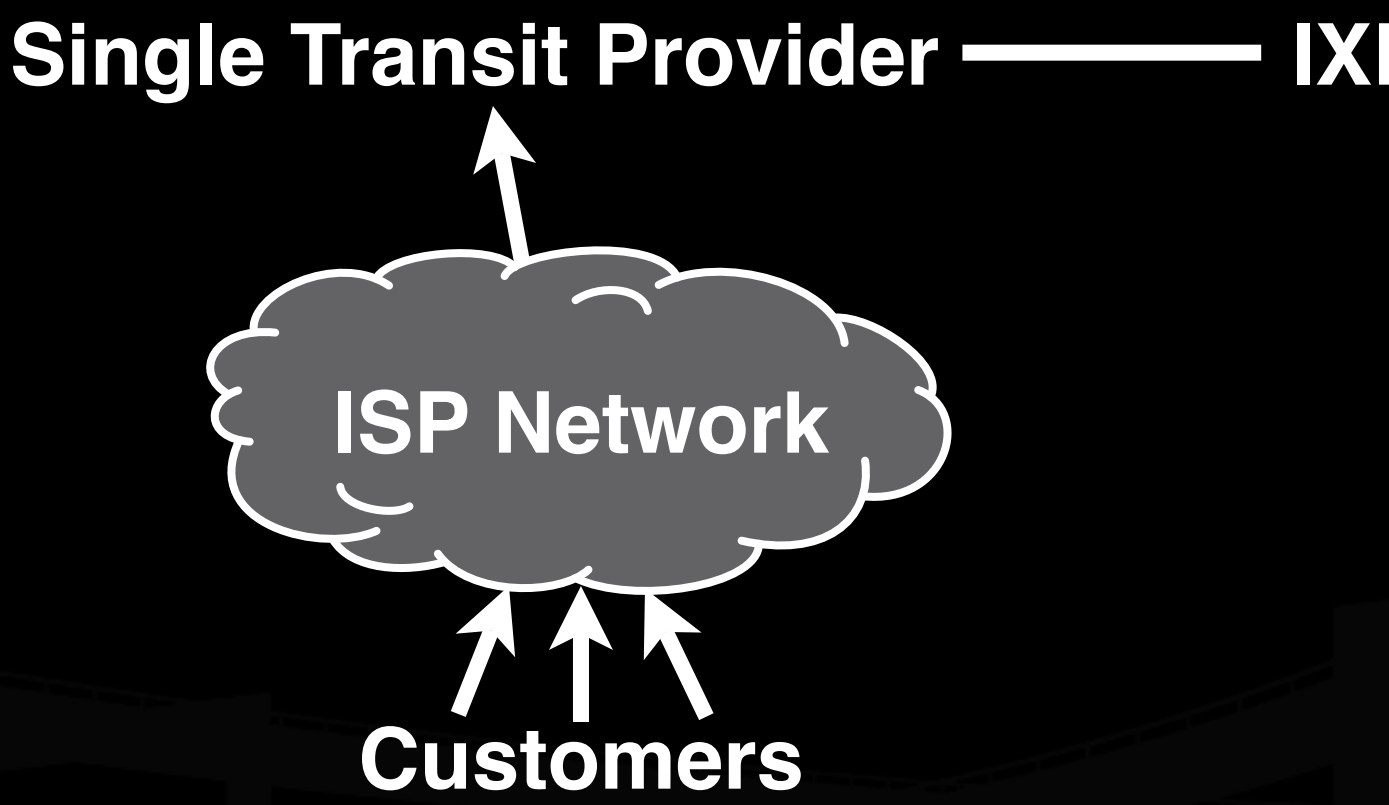
ISP Lifecycle: Simple Aggregator



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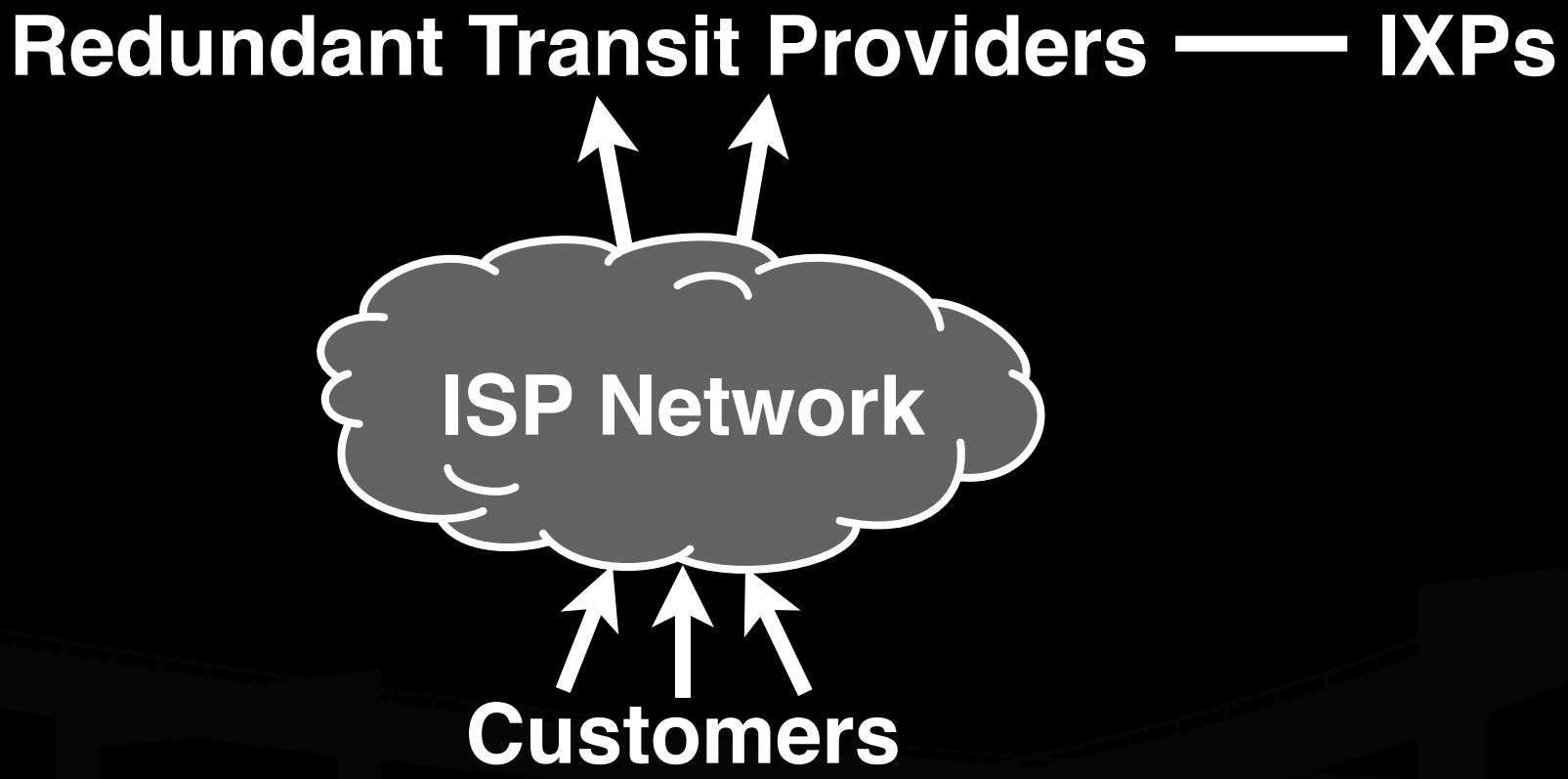
ISP Lifecycle: Redundancy and LCR



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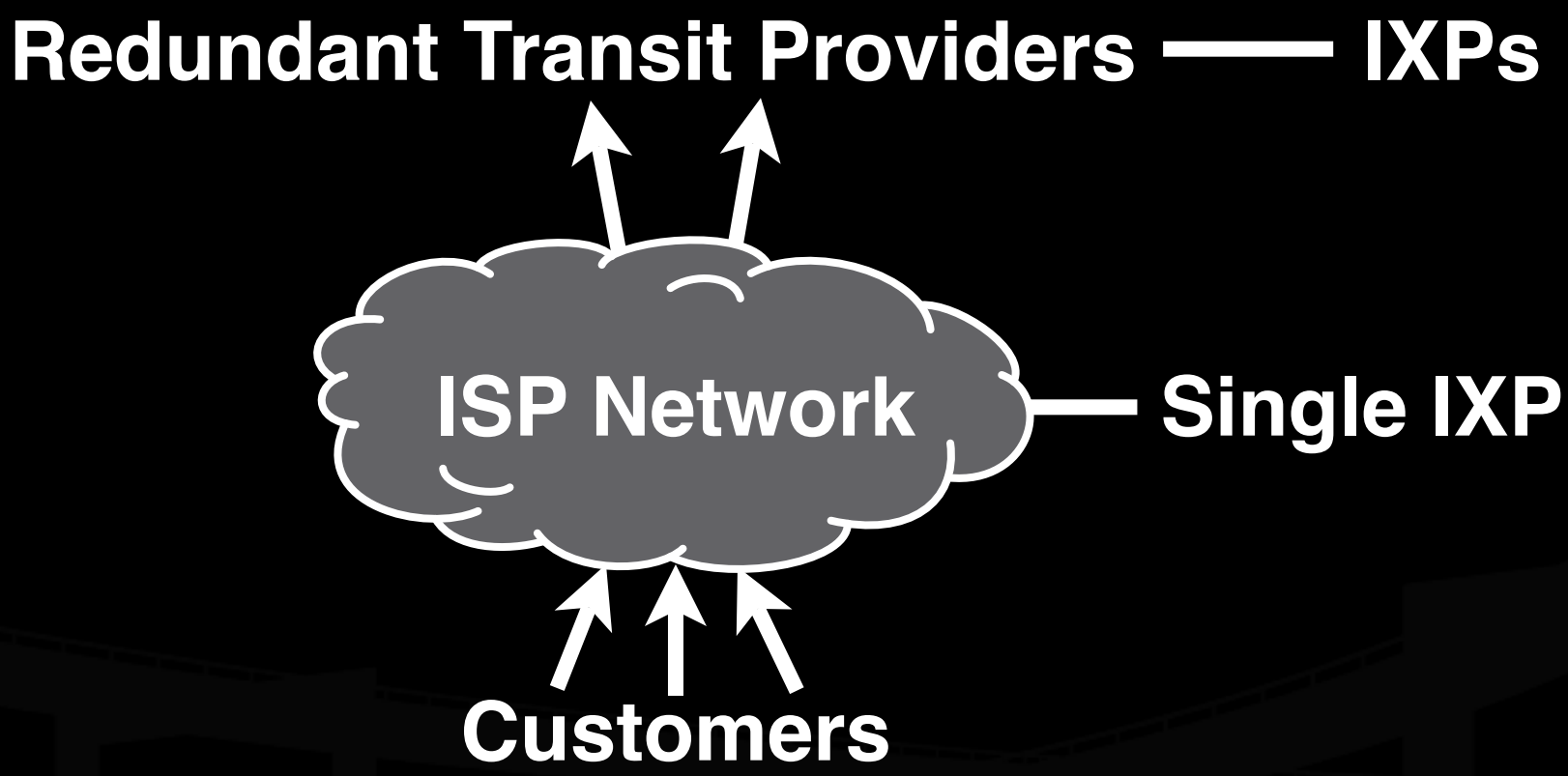
ISP Lifecycle: Local Peer



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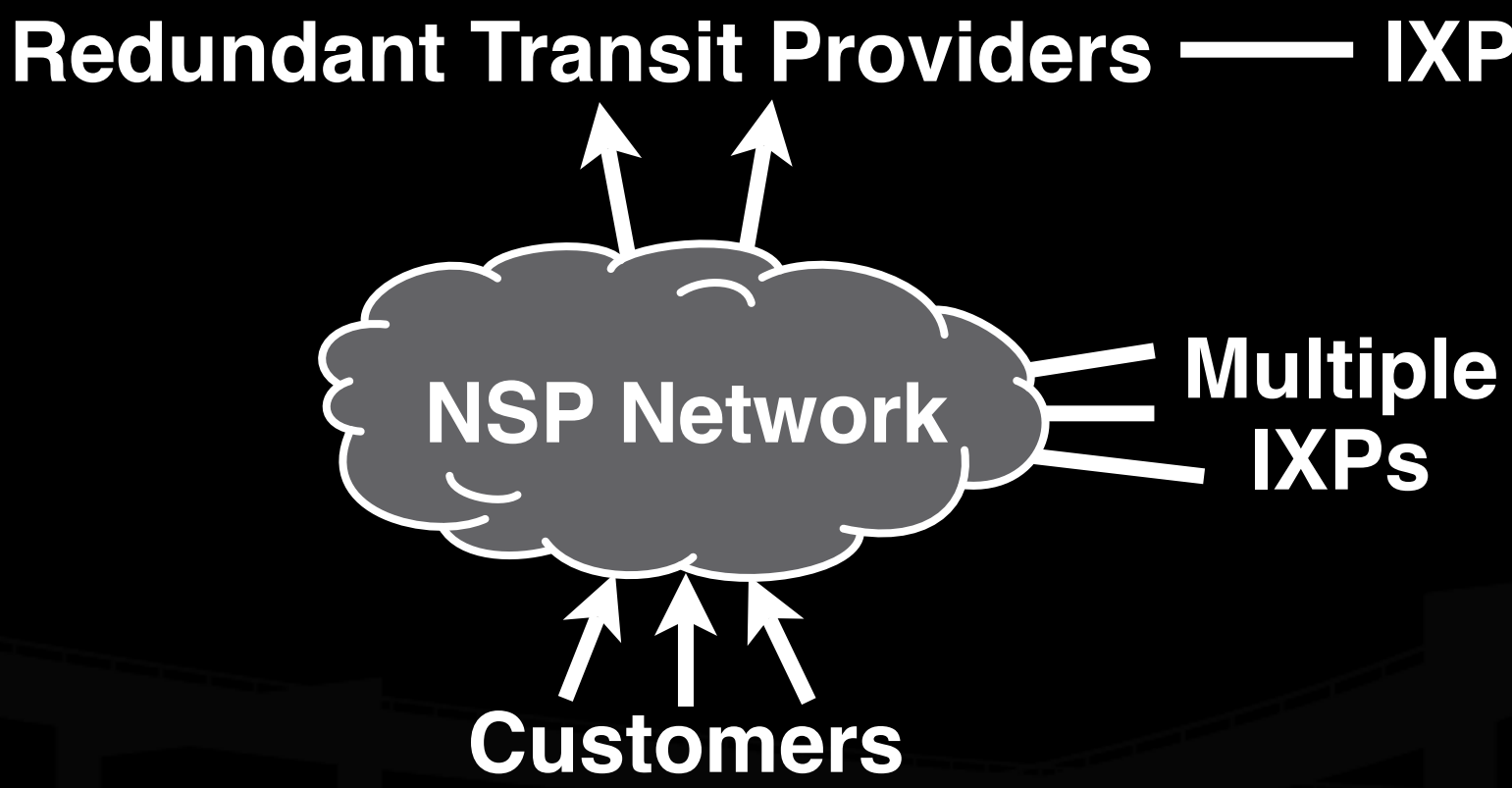
ISP Lifecycle: Network Service Provider



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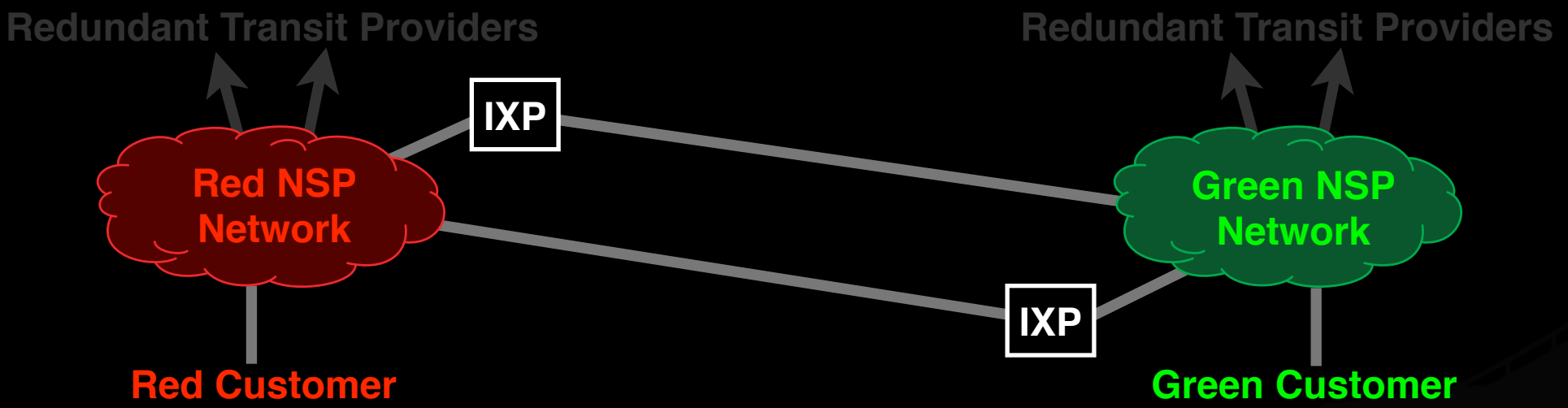
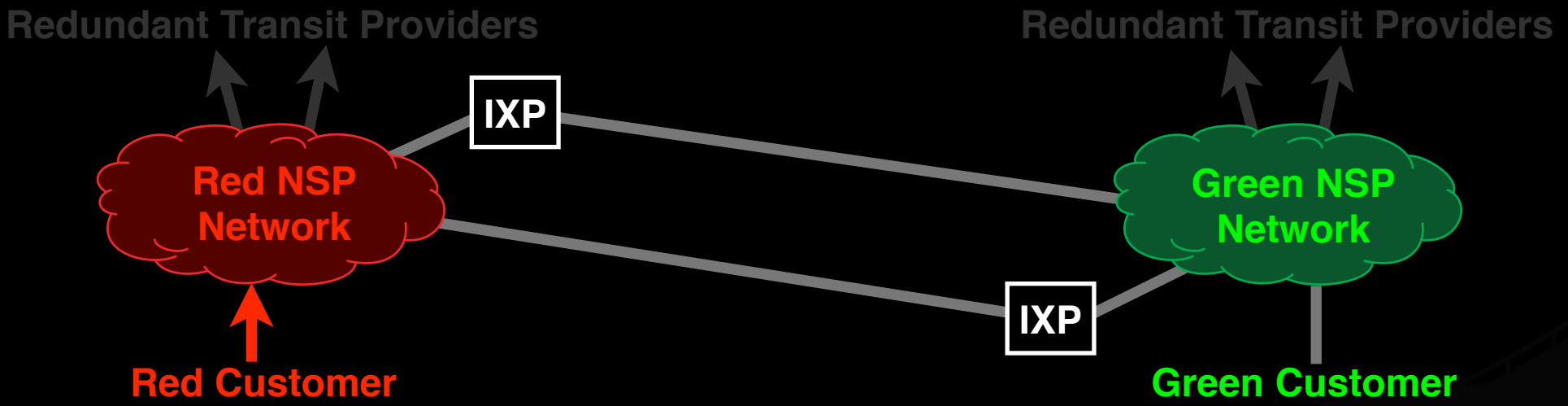
Hot Potato Routing



Hot Potato Routing

Red Customer sends to Green Customer via Red NSP



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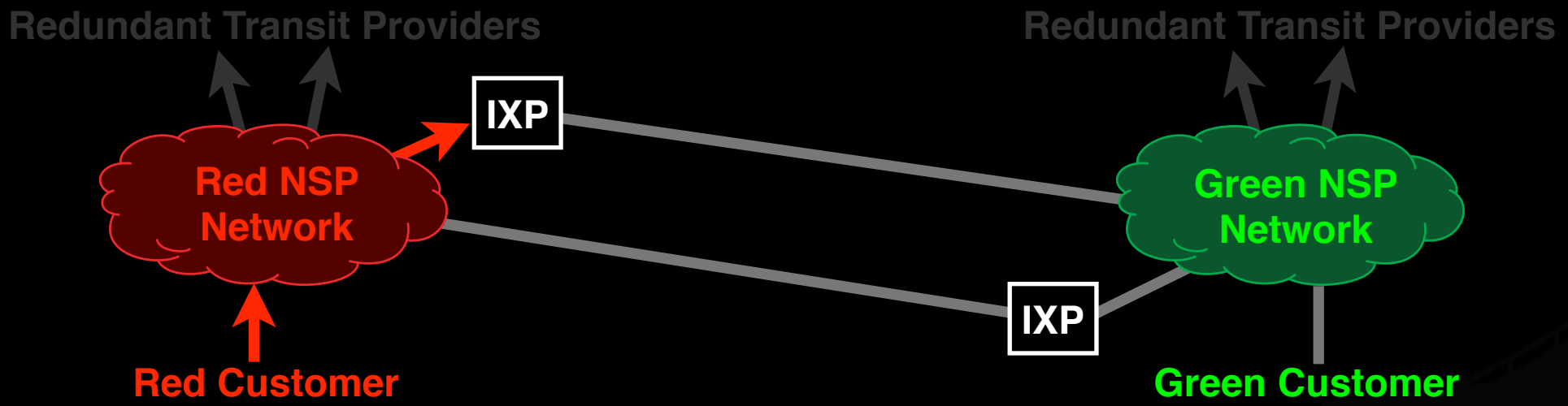
Hot Potato Routing

Red NSP delivers at *nearest* IXP



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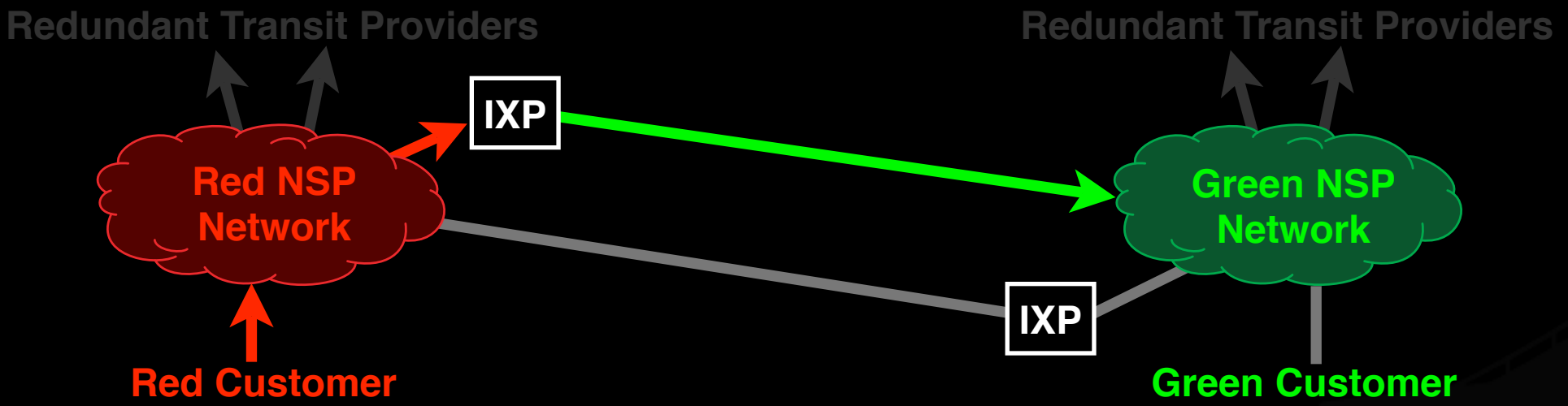
Hot Potato Routing

Green NSP backhauls from distant IXP



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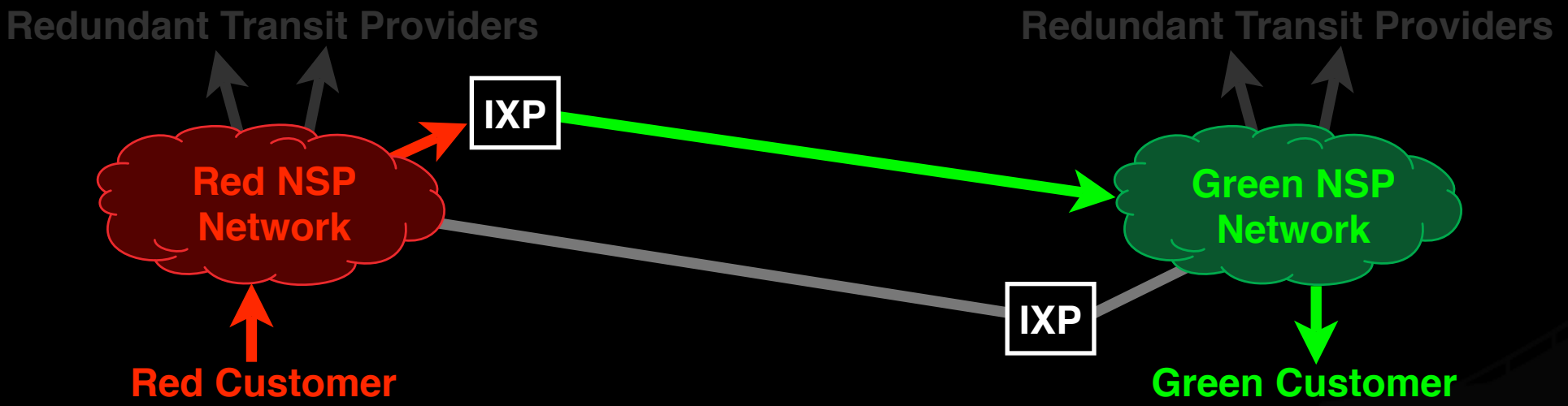
Hot Potato Routing

Green ISP delivers to Green Customer



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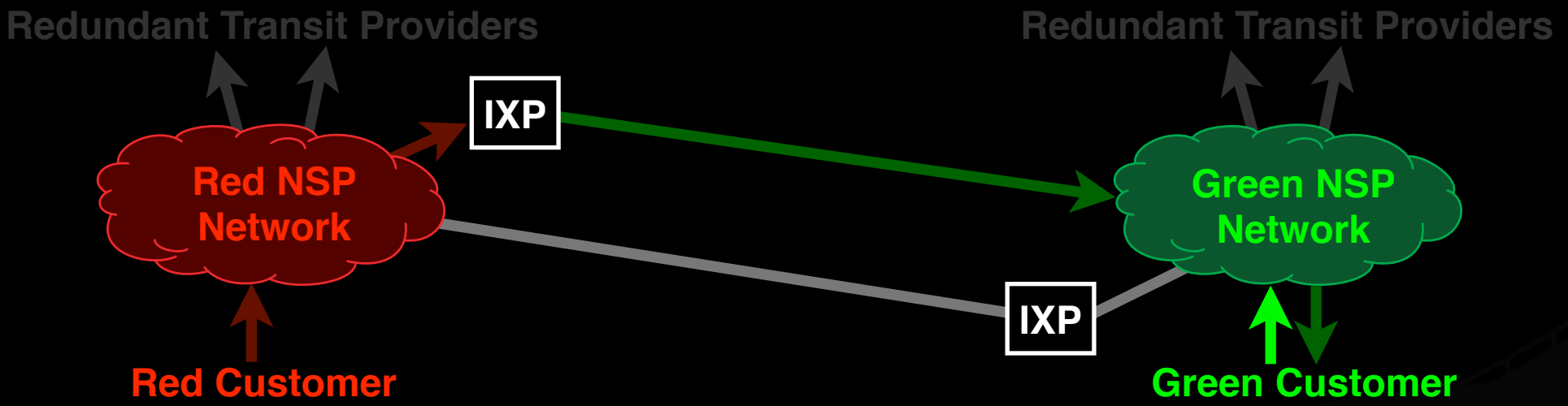
Hot Potato Routing

Green Customer replies via Green NSP



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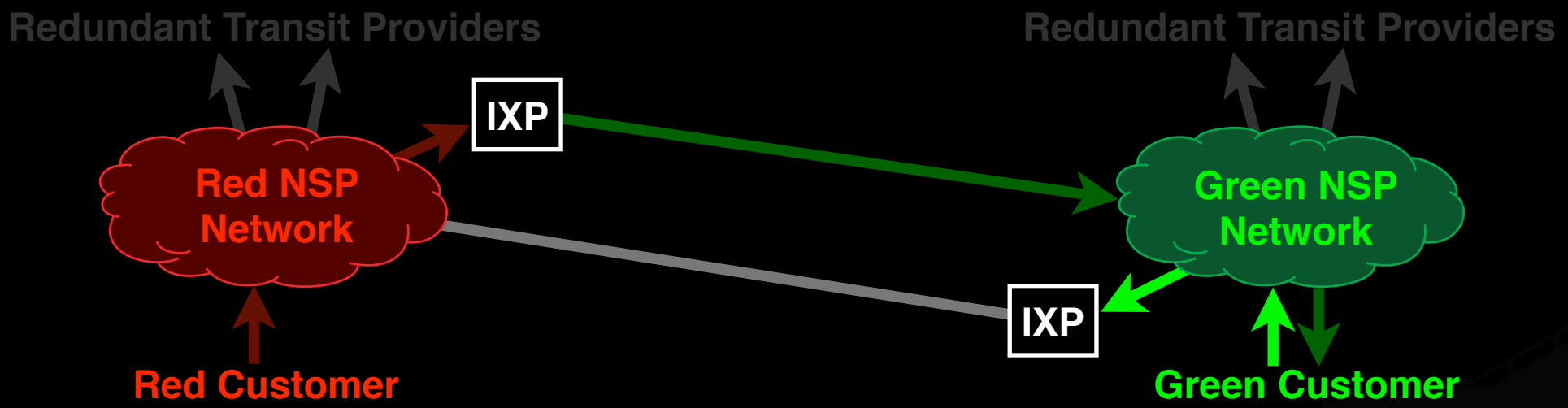
Hot Potato Routing

Green NSP delivers at nearest IXP



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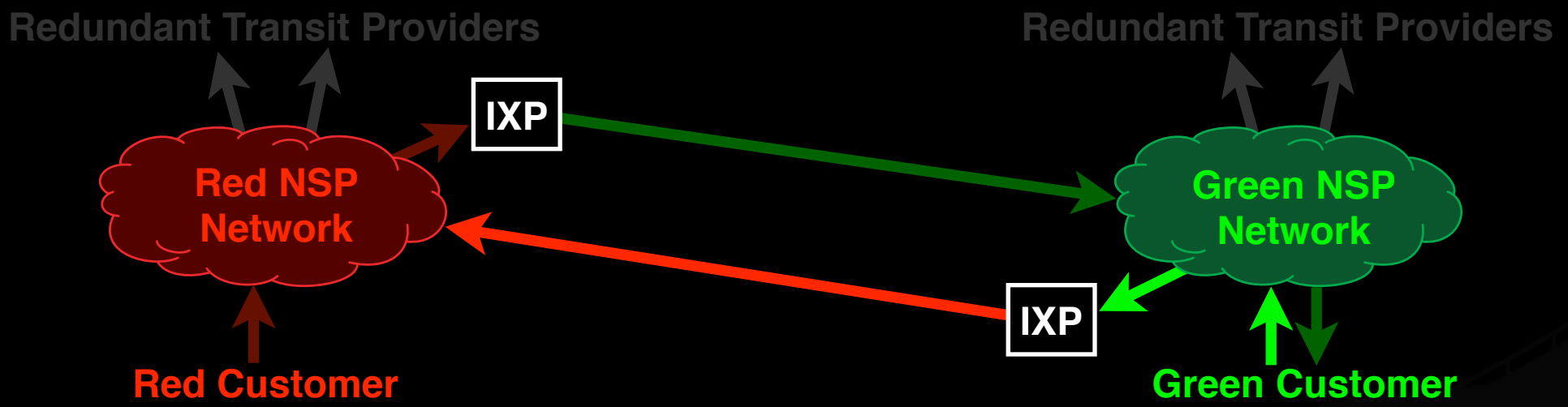
Hot Potato Routing

Red NSP backhauls from distant IXP



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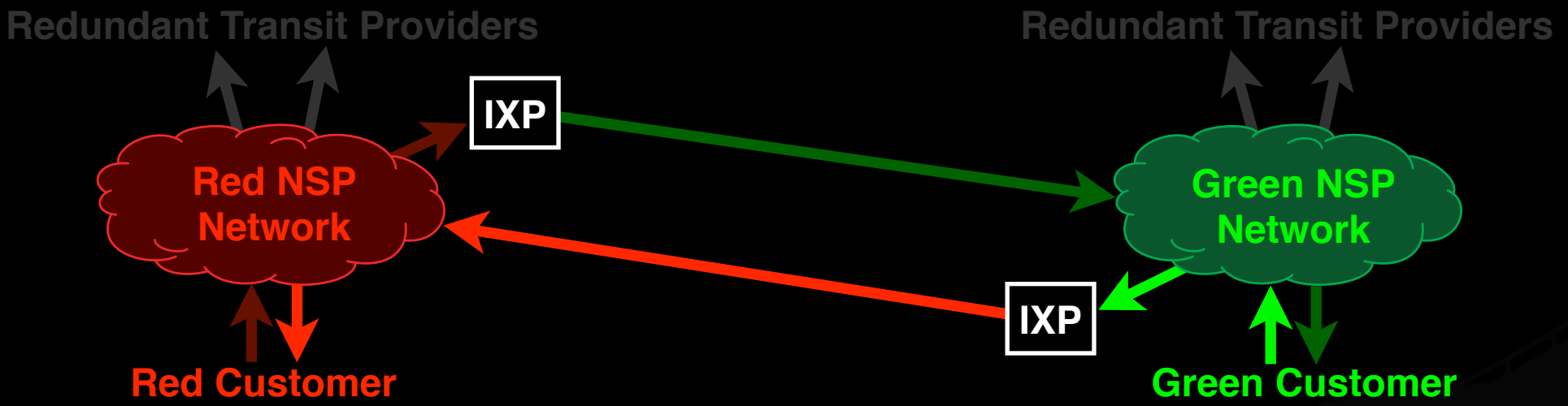
Hot Potato Routing

Red NSP delivers to Red Customer



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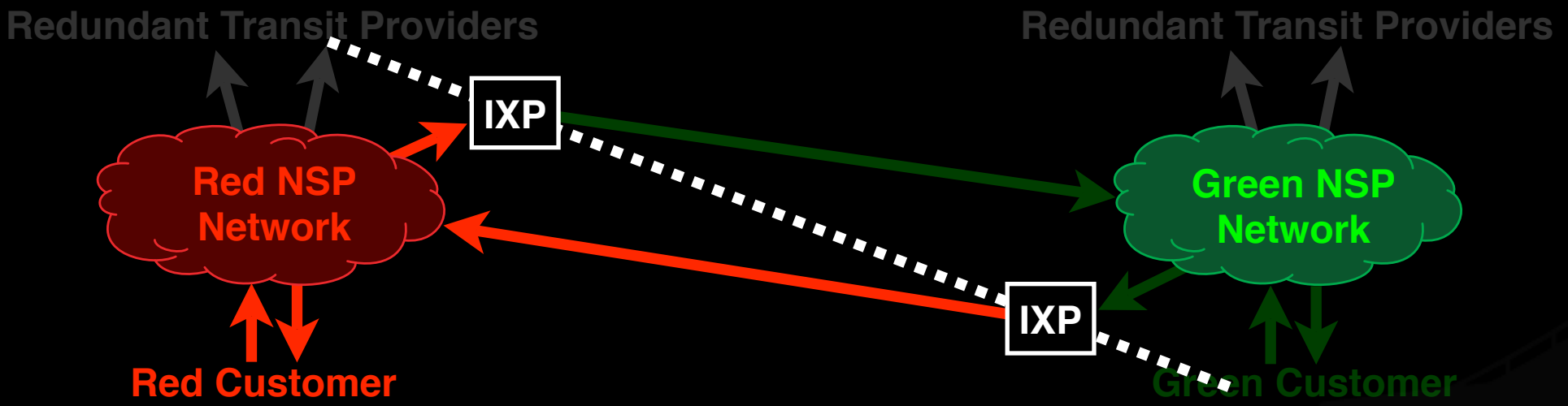
Hot Potato Routing

Red Network is responsible for its own costs



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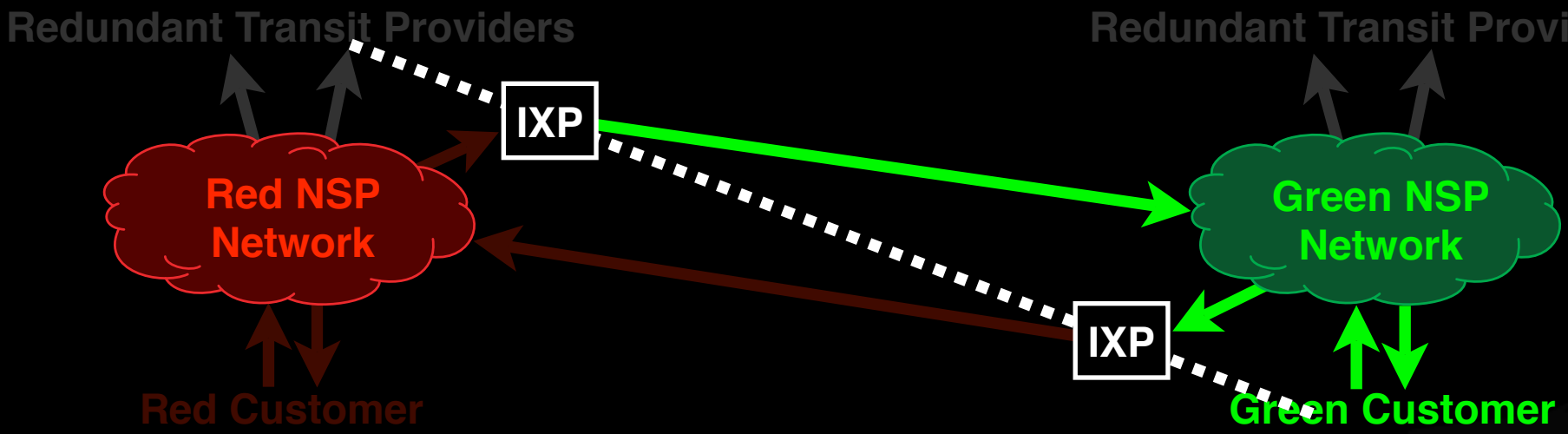
Hot Potato Routing

Green Network is responsible for its own costs



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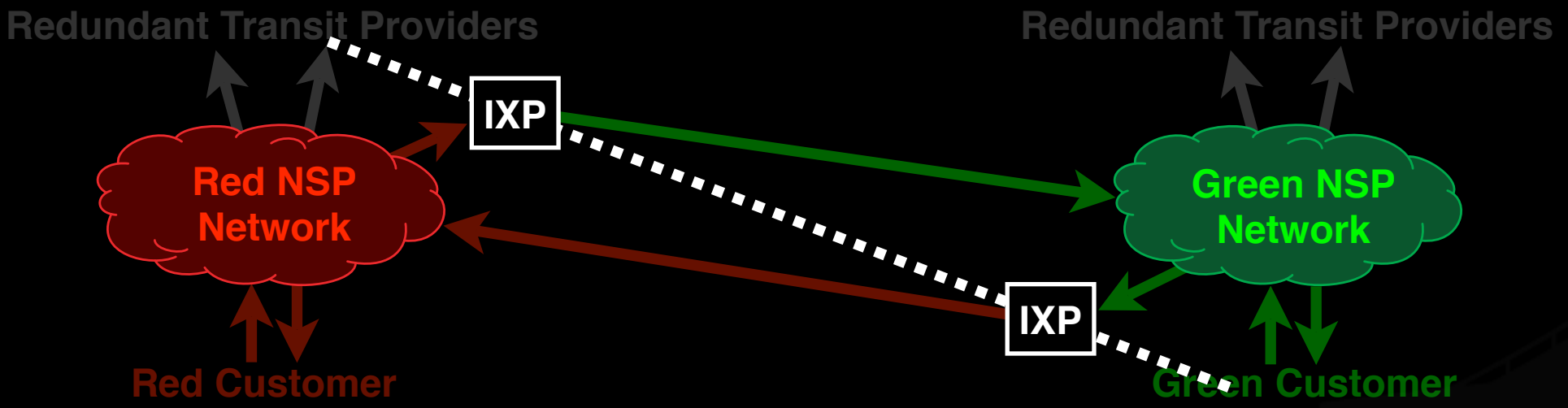
Hot Potato Routing

Symmetry: Fair sharing of costs



The old circuit-switched networks have dubbed our financial model “bill and keep”

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Tools for thinking about Internet Exchanges in economic terms

What are we, as ISPs, selling?

- The right to modulate bits.
- That right is a perishable commodity.
- Where do we get the potentially-modulatable bits?

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The right to modulate bits

Any Internet connection is a serial stream of time-slices.

Each time-slice can be modulated with a binary one or zero, one bit.

Each customer purchases potentially-modulatable bits at some *rate*, for example, 2mbps, which is 5.27 trillion bits per monthly billing cycle.

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That's a perishable commodity

The quality (as opposed to quantity-per-time) characteristics of an Internet connection are *loss*, *latency*, *jitter*, and *out-of-order delivery*.

Loss increases as a function of the number and reliability of components in the path, and the amount of contention for capacity.

Latency increases as a function of distance, and degree of utilization of transmission buffers by competing traffic sources.

Jitter is the degree of variability in loss and latency, which negatively affects the efficacy and efficiency of the encoding schemes which mitigate their effects. Jitter increases relative to the ratio of traffic burstiness to number of sources.

Out-of-order delivery is the portion of packets which arrive later than other, subsequently-transmitted packets. It increases as a function of the difference in queueing delay on parallel paths.

All of **these properties become worse with time and distance**, which is a reasonable definition of a perishable commodity.

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So where do we get the bits?

The value of the Internet is communication.

The value is produced at the point at which communication occurs between two ISPs, and it is transported to the customers who utilize it.

Thus, all the bits we sell come from an Internet exchange, whether nearby, or far away.

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An analogy

Let's look at another perishable commodity with more readily observed economic properties... **Bananas**.

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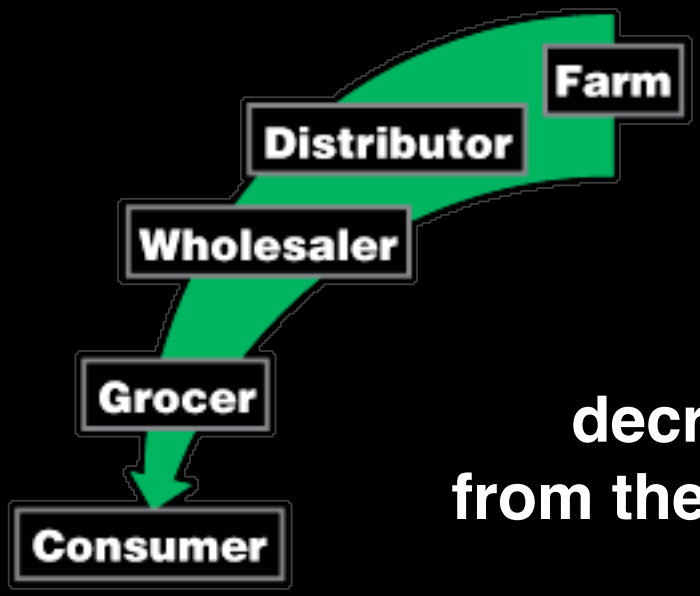
Value decreases with time & distance



The value of a banana decreases, the further it gets from the farm which produced it.

The shelf-life which the consumer can expect decreases, and eventually it becomes overripe, then rotten.

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Cost increases with time & distance

The cost of a banana increases, the further it gets from the farm which produced it.

Salaries and hourly labor, warehouse leasing, diesel fuel, truck amortization, loss and spoilage, insurance, and other factors contribute additively.

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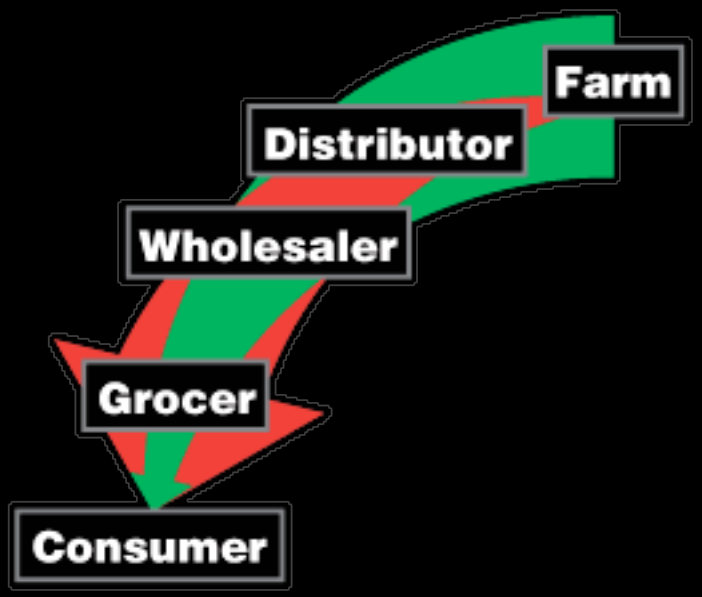

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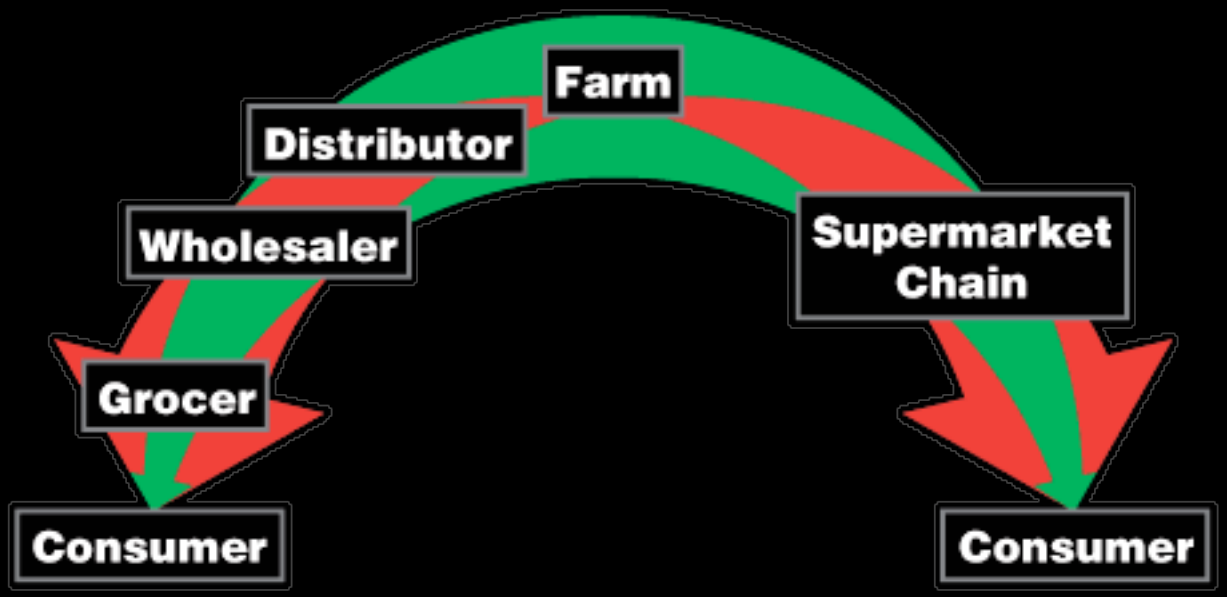

In a competitive environment, retail price is limited by competition, so time and distance influence the price more than the number of middlemen.

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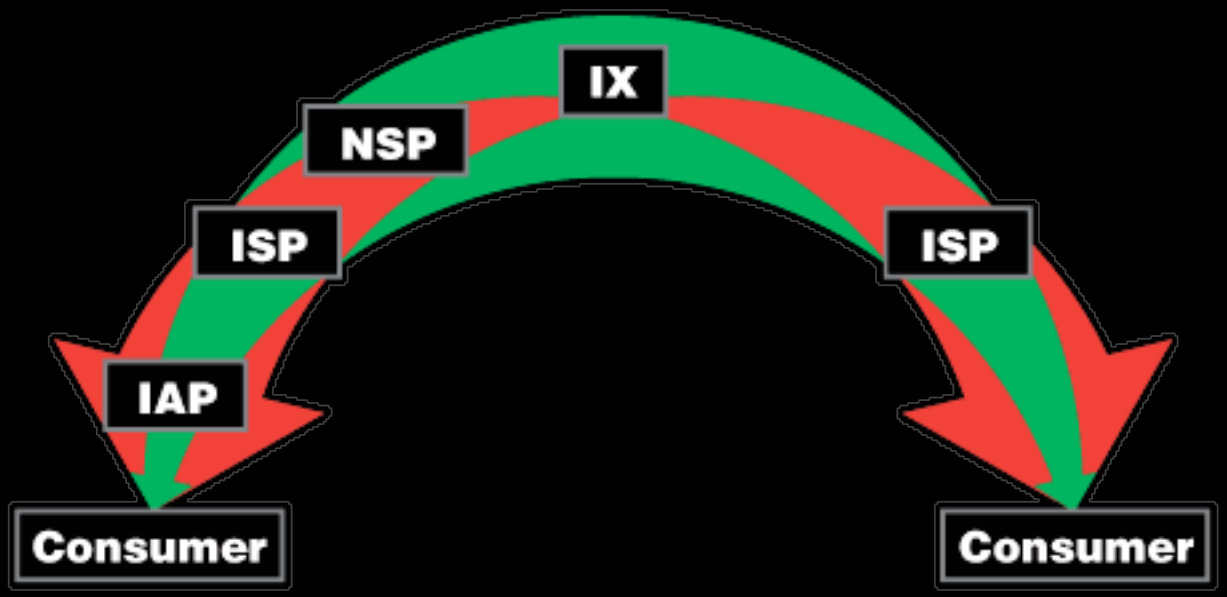
The problem is the same:



ISPs form a delivery chain, bringing perishable bits to the consumers who purchase them.

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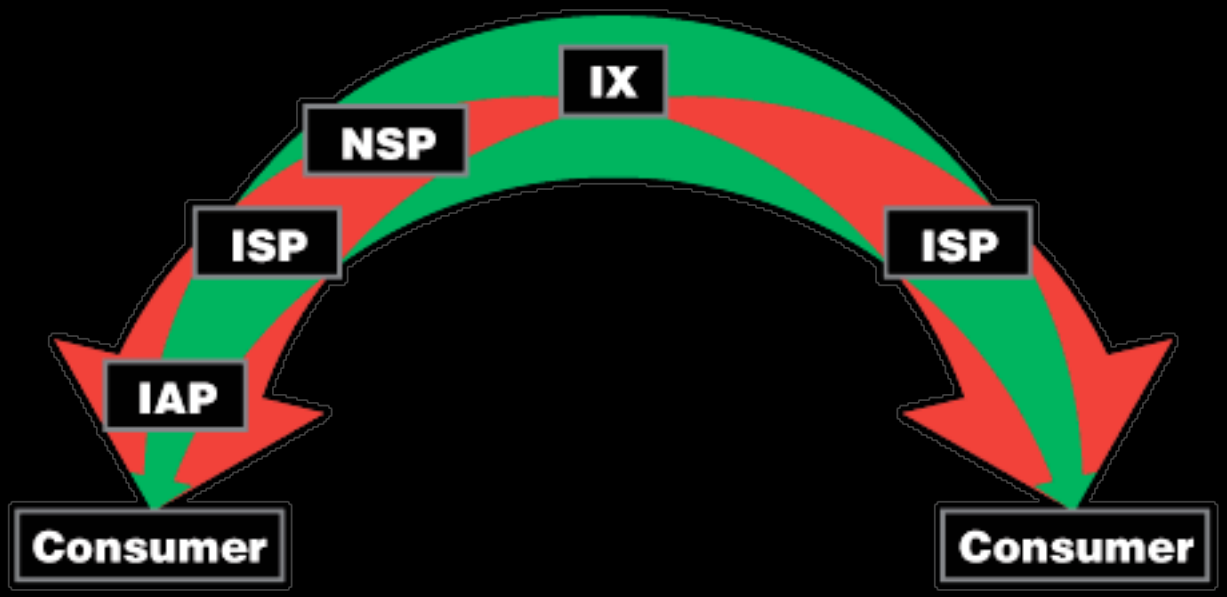
So how do we improve things?



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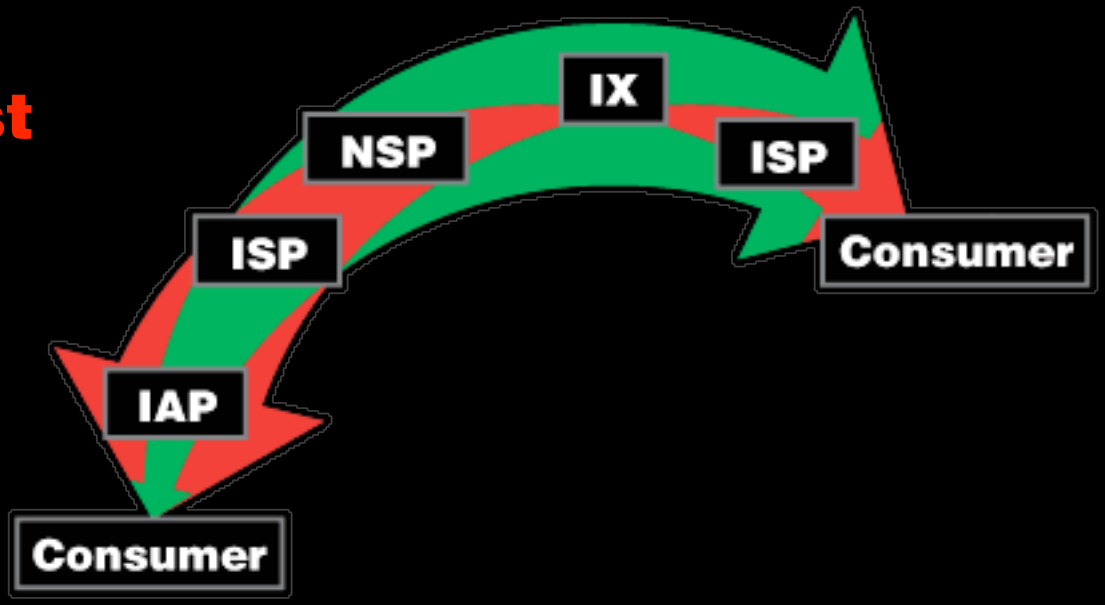
Bring the customer nearer an IX...

High cost
Low value



Low cost
High value

...or bring an IX nearer the customer.

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So how do we recognize a successful exchange?

The purpose of an IX is to lower participating ISPs' average per bit delivery costs (APBDC).

A cheap IX is probably a successful one.
An expensive IX is always a failure.
Reliability is just hand-waving by salespeople.

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Determining Need

Sufficient end-user base?
No existing facility to build upon?
Sufficient degree of locally-destined traffic?

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Geographic Location

User population
Fiber facilities or rights-of-way
Founding participants

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Density

Centralized in one room
Campus of adjacent buildings
MAN
Frame or ATM cloud

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Building Management

Telco hotel
University computing or
telecommunications facility
City emergency services facility

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In-Building Facilities

Pathways
Power
Cooling
Access and security

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Services

Switch fabric
Crossconnects
Route-server
Remote hands
NTP
Web caching

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Business Structure

Incorporated or unincorporated?
Staffed or volunteer?
Non-profit or for-profit?
Cooperative or external ownership?
Cost-recovery (predictive or actuals), ad-hoc, or market pricing?

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Policies

BLP, MLPA or MMPLA?
Mandatory looking-glass?
Routing and switch-port information public or members-only?
Secrecy in the event of security problems, failures, or mistakes
Extensible switch fabric?

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Thanks, and Questions?

Copies of this presentation can be found
in Keynote, PDF, QuickTime and PowerPoint formats at:

http:// www.pch.net / resources / tutorials / ix-construction

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