

The Economics of Internet traffic exchange.

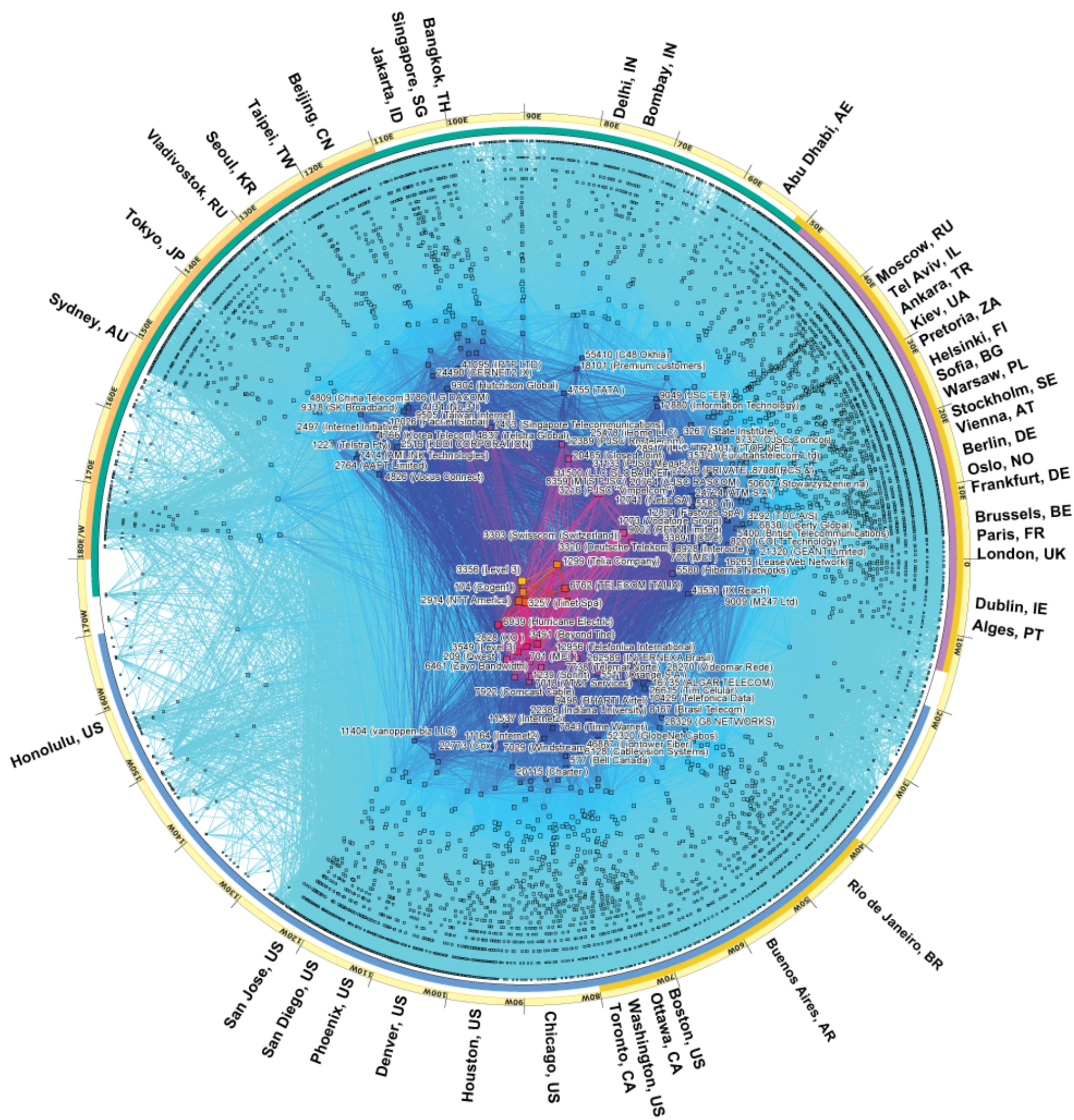
Nishal Goburdhan
Packet Clearing House
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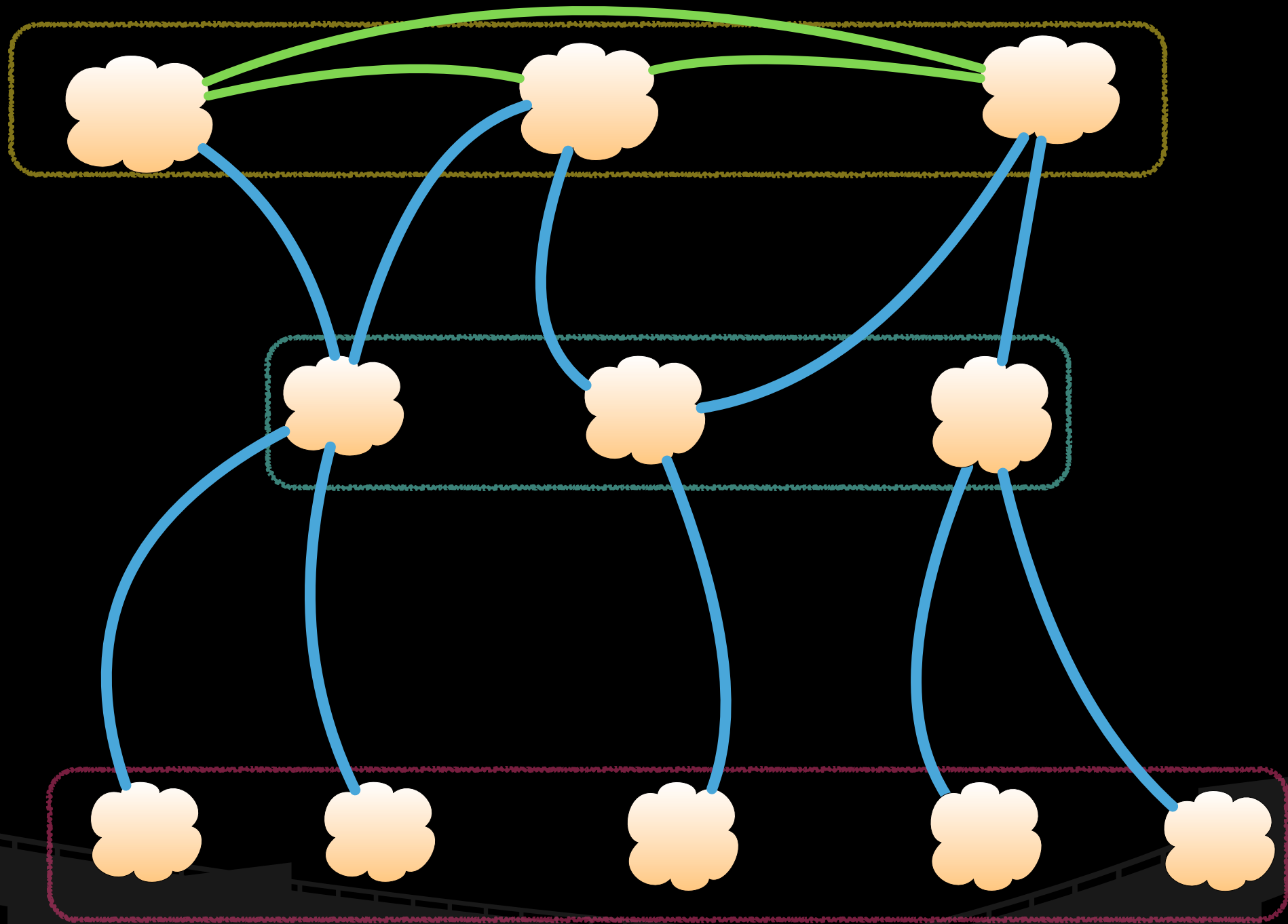
Hello from PCH !

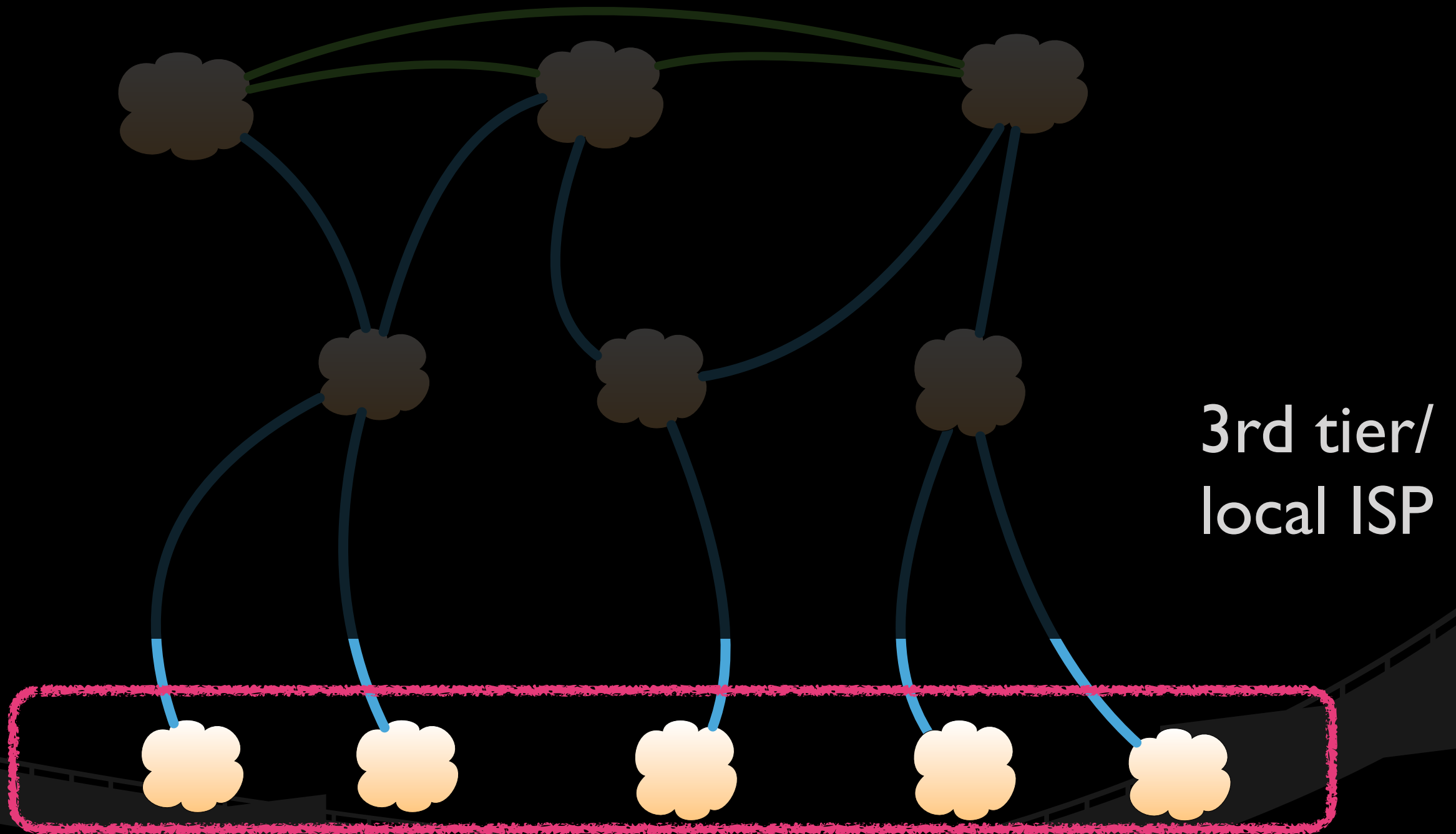
- Global non-profit providing operational support and security to critical Internet infrastructure, including IXPs and the core of the DNS
- Funded by grants, service provision fees from Internet operations industry, and specialised consultancies
- Global footprint with offices in SFO, PAR, DXB and JNB. De-centralised staff in other cities.

Specific to KSA

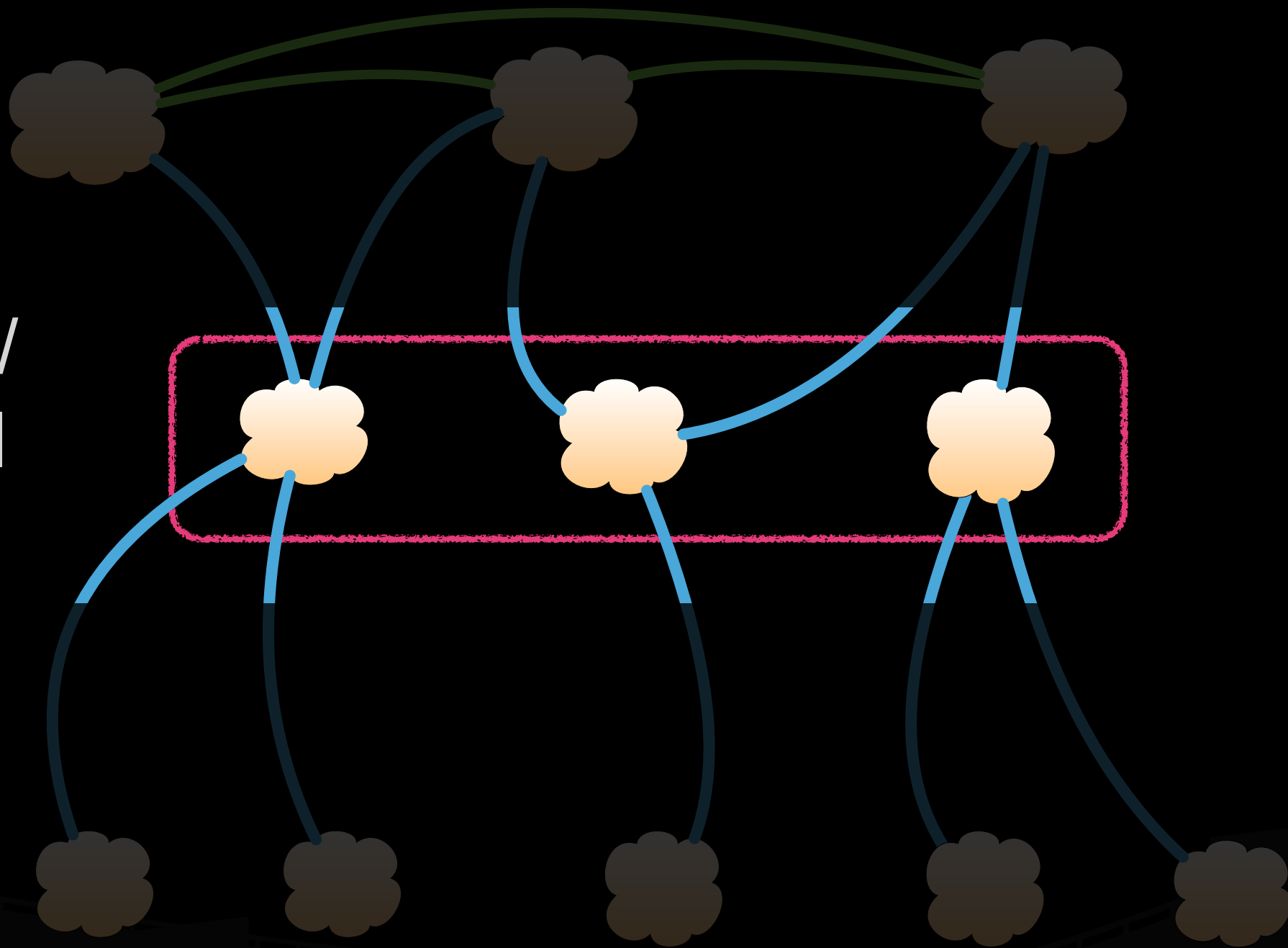
- Provide anycast DNS services for .SA at more than 300 locations globally for 25+ years
- Host a PCH anycast DNS node at the SAIX in Riyadh.
- Produced peering optimisation paper for SAIX.
- Presently working on a consultative paper for the MCIT on improving KSA's peering ecosystem.



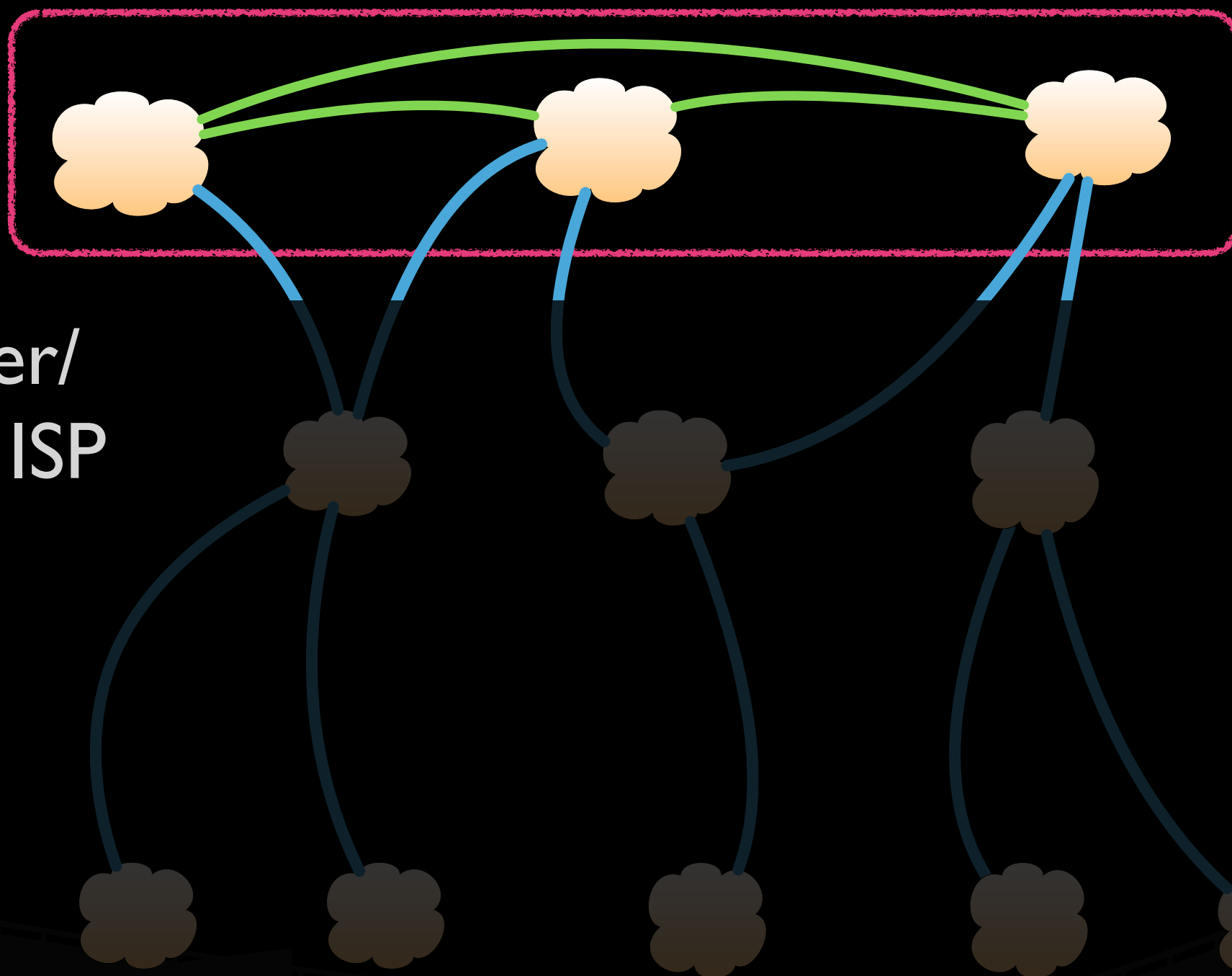


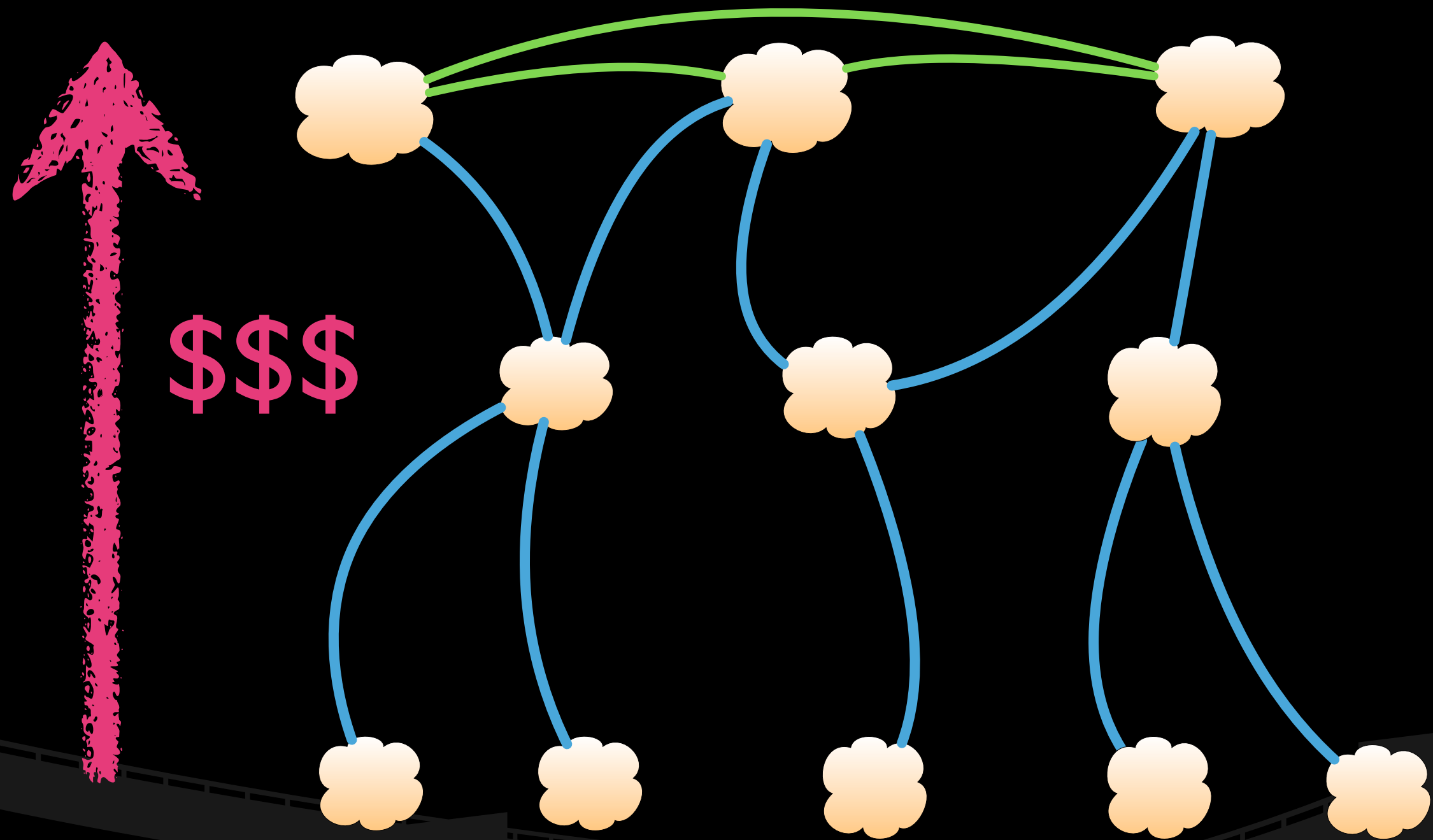


2nd tier/
regional
ISP

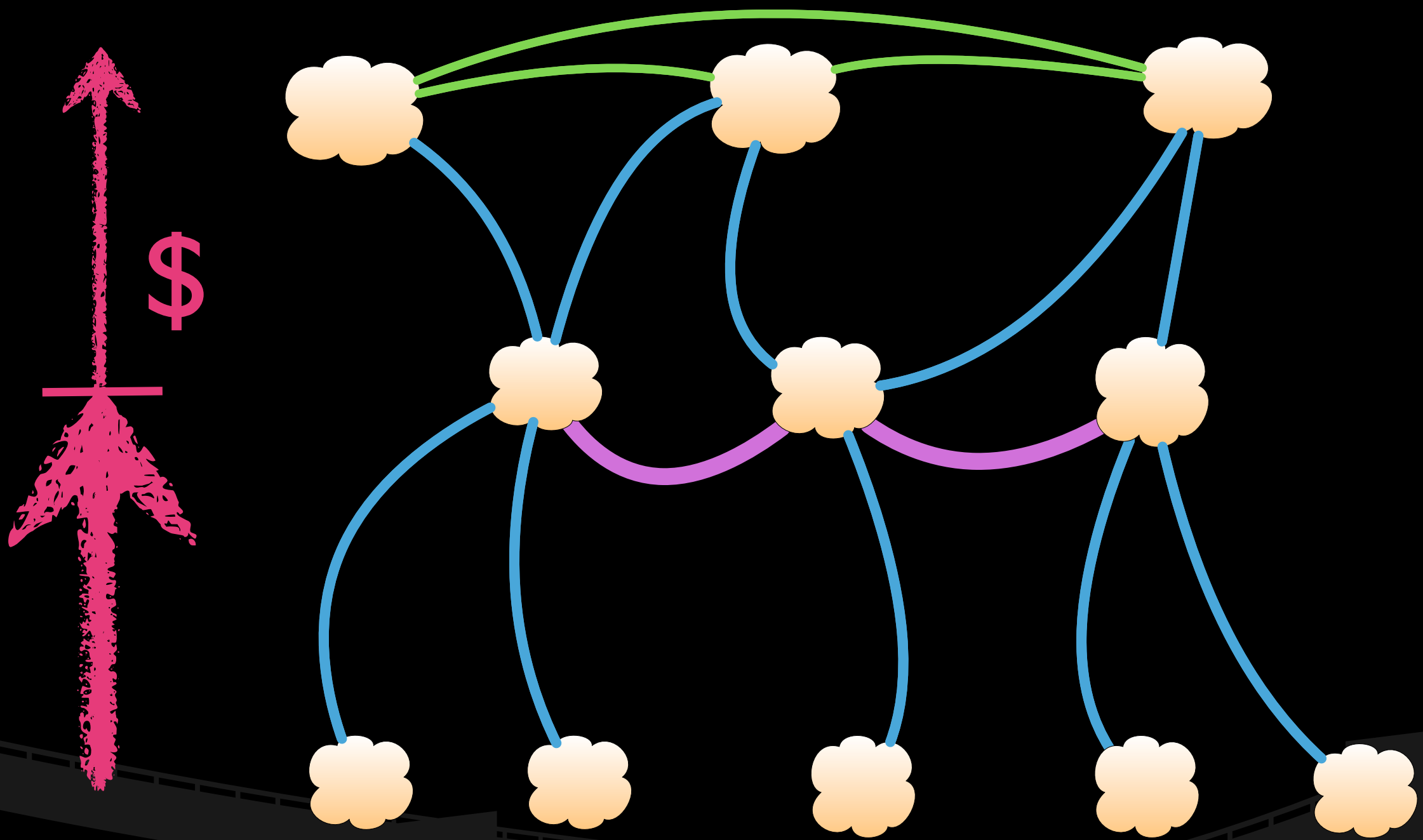


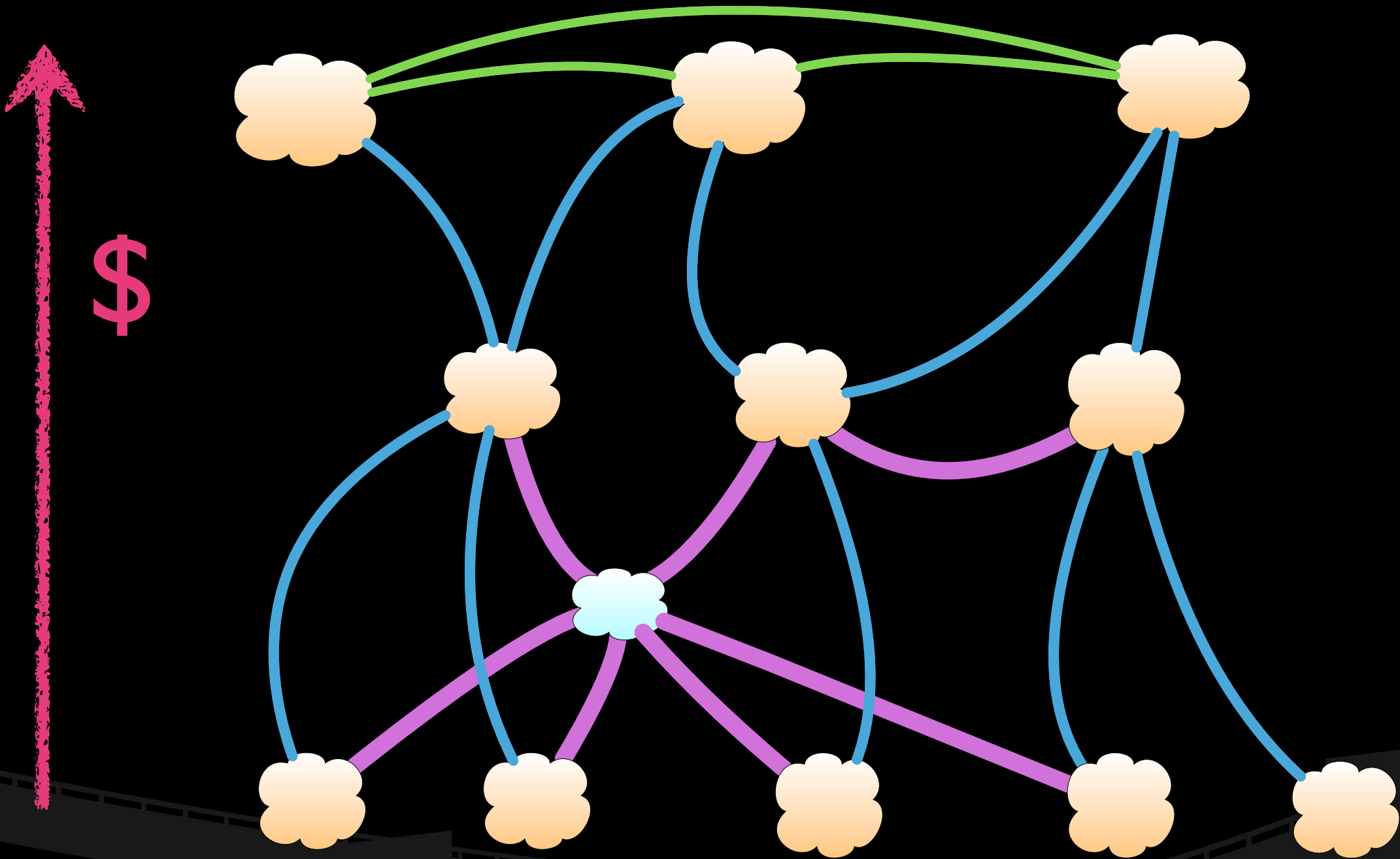
1st tier/
global ISP





Transit



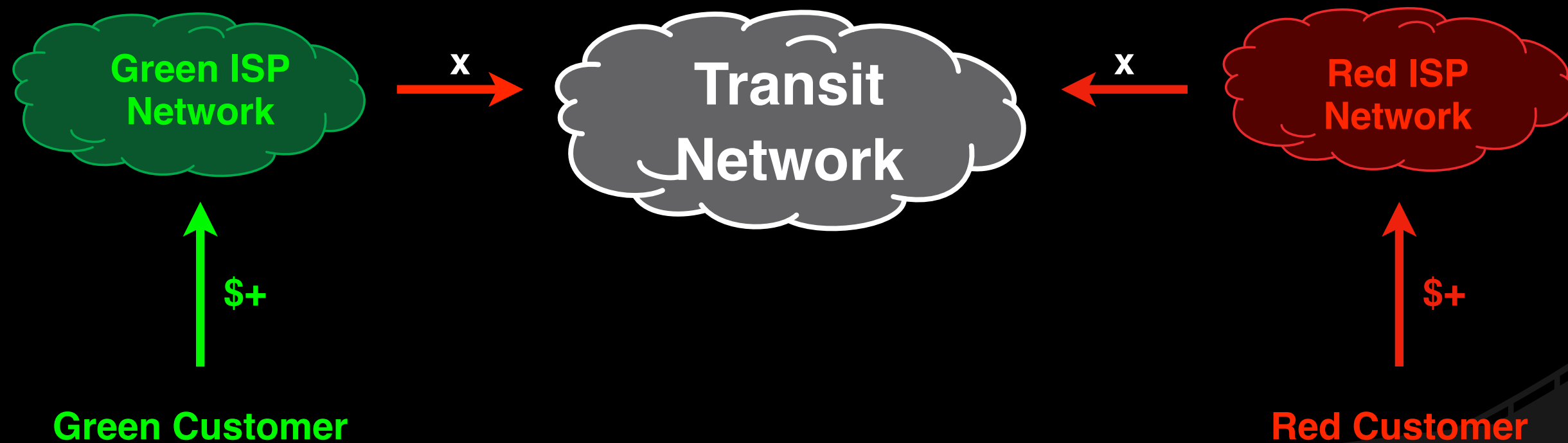


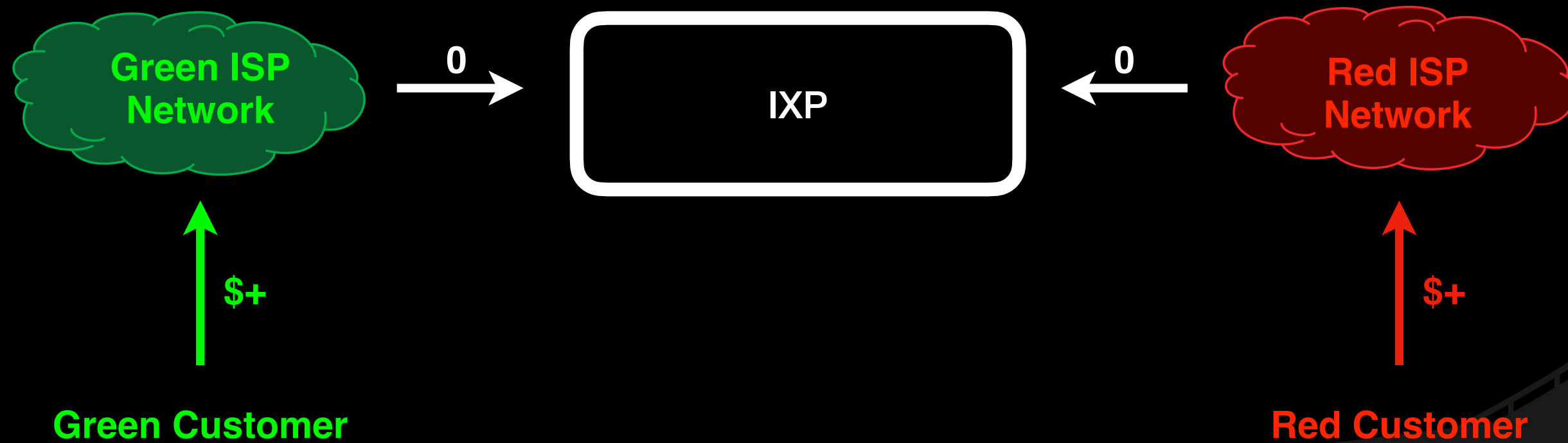
Transit and Peering

- **Transit agreements are commercial contracts** in which a customer pays a service provider for access to the entire Internet. Transit agreements are most common at the edges of the Internet.
 - Example: a corporate customer of a local ISP that provides Internet connectivity and managed ICT services.
- **Peering agreements** are the carrier interconnection agreements that allow carriers to exchange traffic bound for one another's customers; they are most common in the core of the Internet and are the true creators of value of the Internet.
 - Example: networks at an IXP with a free-settlement peering agreement



Earnings: 2





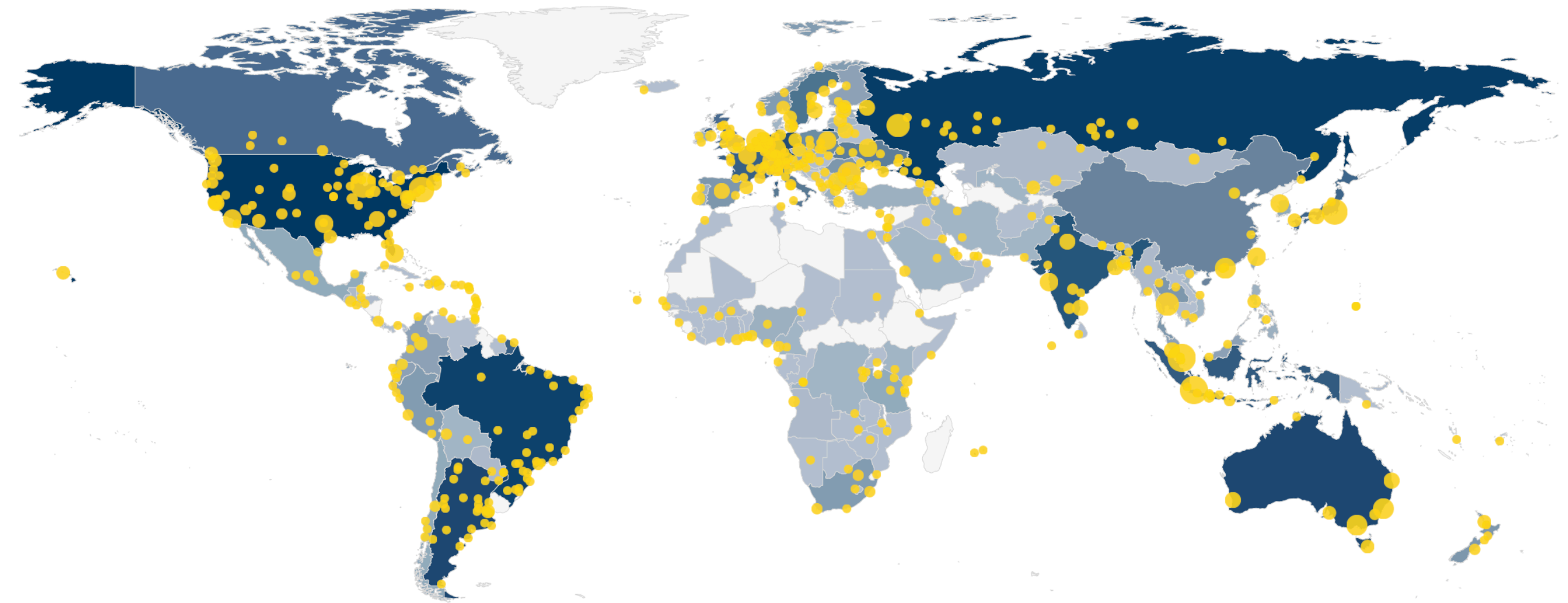
Rational self-interest

Any rational network operator will always seek to maximise their peering ...

How we interconnect

- Cost drives build to simplicity
- Physical infrastructure (layer 2 switching) that facilitates network interconnection.
 - Cost and performance benefit (direct routes are the cheapest!)
 - Natural ecosystem for content driven systems to develop (traffic aggregation point).
 - Improved skills and knowledge (workforce and job creation)
 - Increases autonomy as a region.
 - Privacy and cyber security advantages

Internet Exchange Directory



The Internet Lifecycle (from an ISP's perspective)

**But first ... How many of you
run / want to run a “Cloud”
business?**

From

 ZAR – South African Rand



To

 USD – US Dollar



We use midmarket rates [\(i\)](#)

[Track currency](#)

[View transfer quote](#)

ZAR to USD Chart -35.16% (10Y)

South African Rand to US Dollar

● 1 ZAR = 0.0577543 USD Sep 23, 2024 at 17:37 UTC

1H

1D

1W

1M

1Y

2Y

5Y

10Y

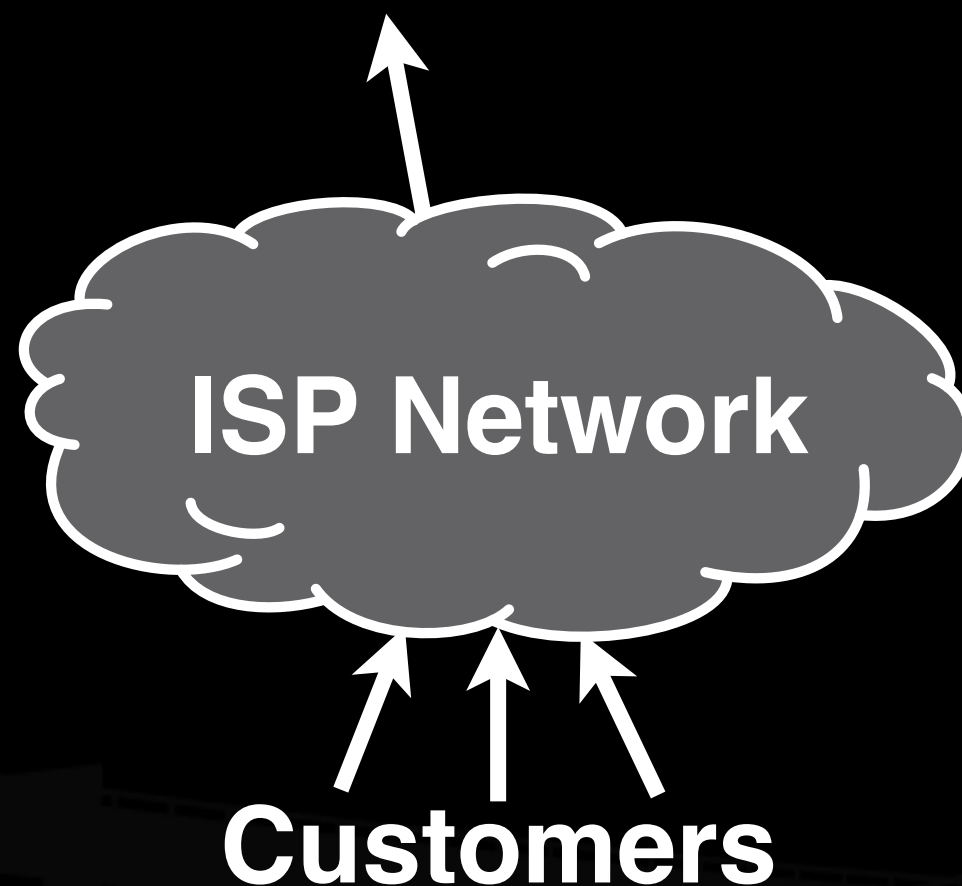


Sep 27, 2014 at 00:00 UTC - Sep 23, 2024 at 17:37 UTC

Source: [xe.com](#)

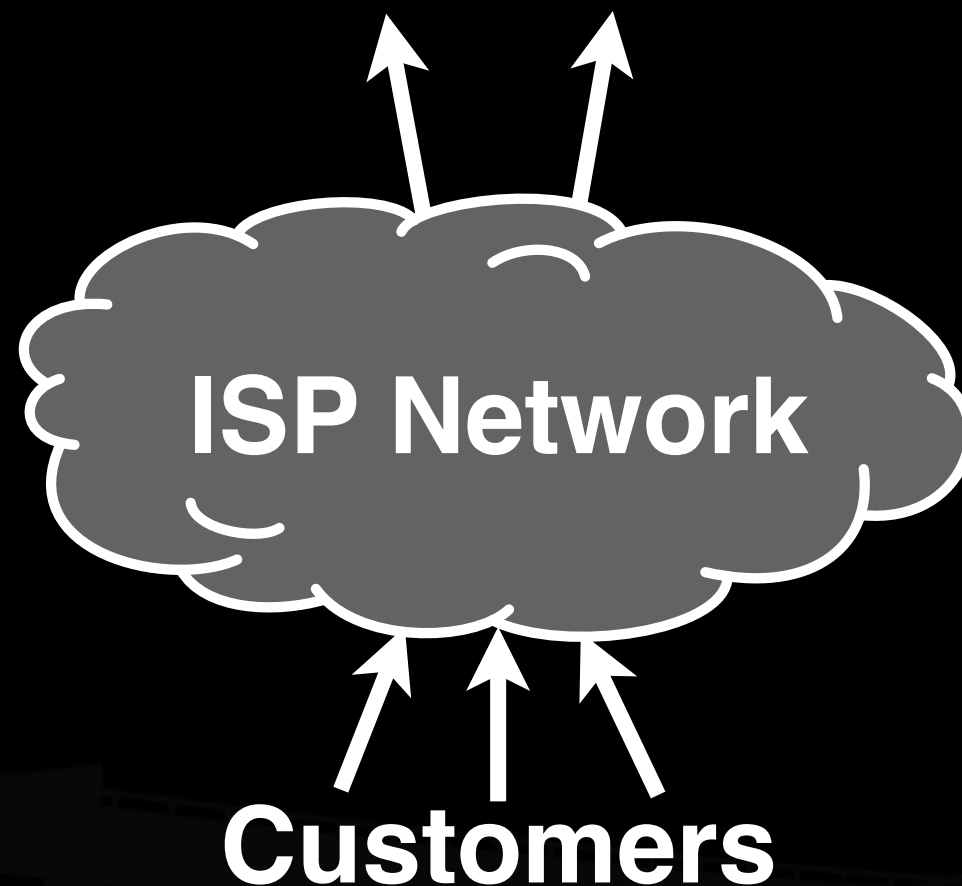
ISP Lifecycle: Simple Aggregator

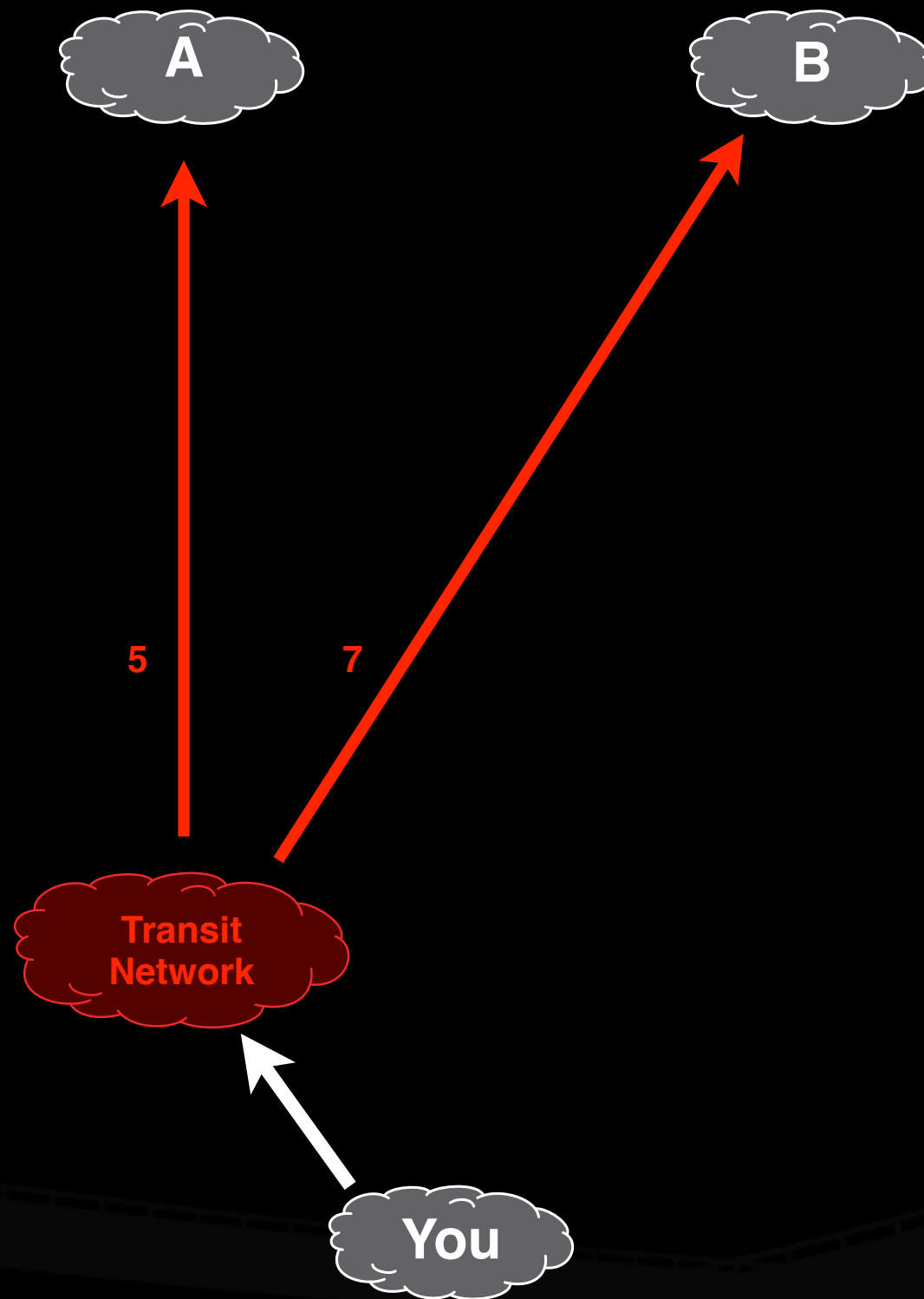
Single Transit Provider ——— IXPs



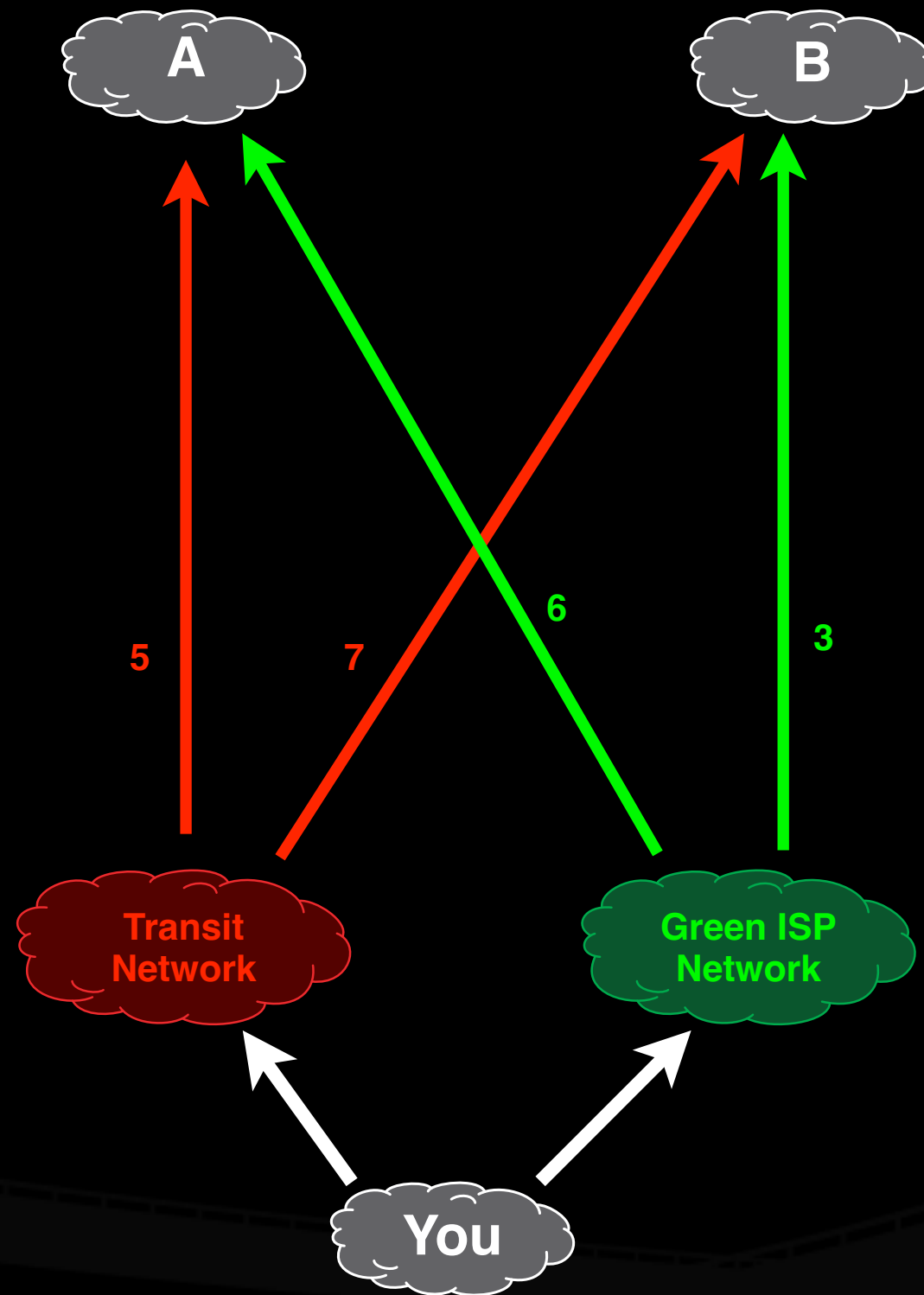
ISP Lifecycle: Redundancy and LCR

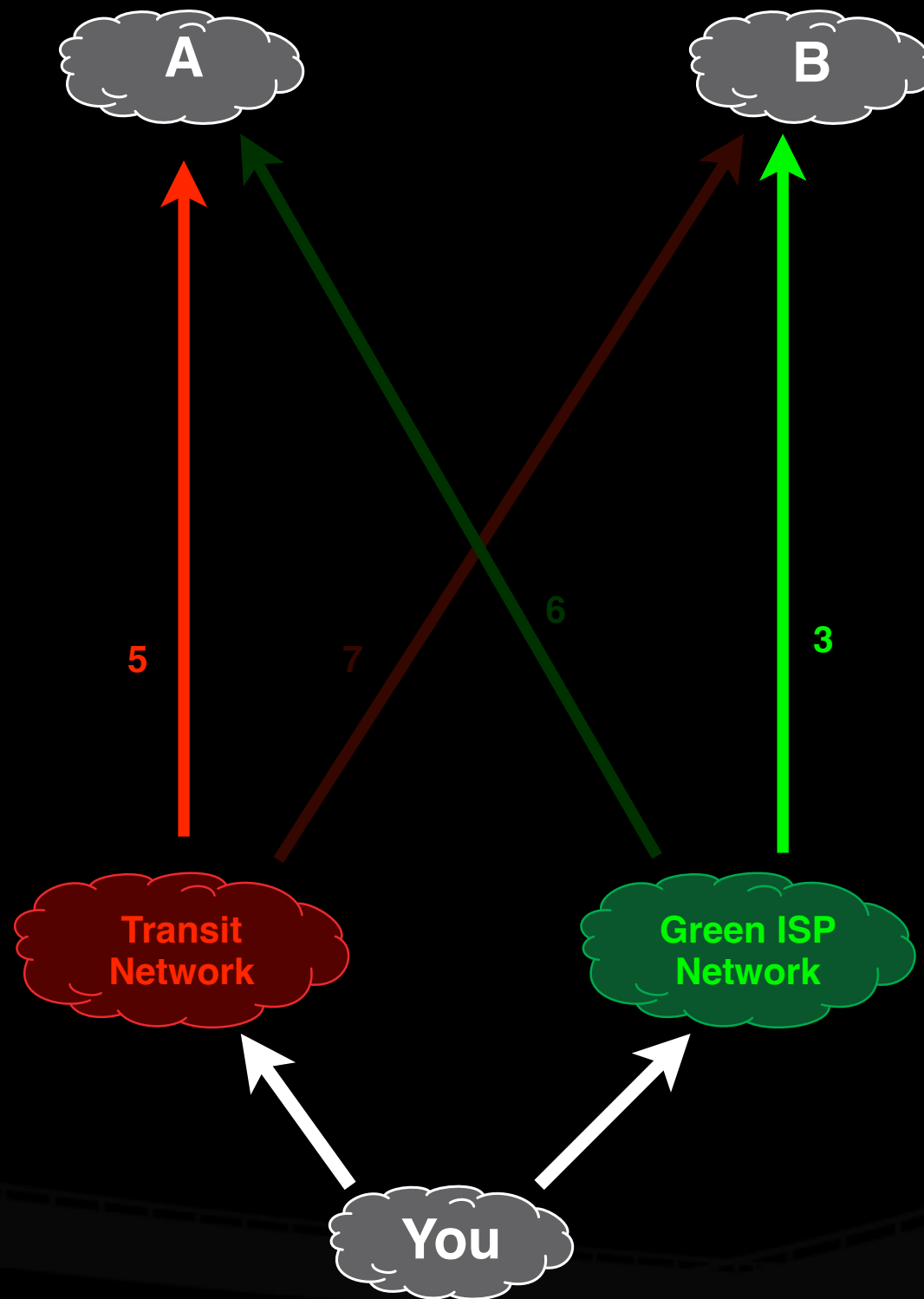
Redundant Transit Providers — IXPs





Ave Length = 6

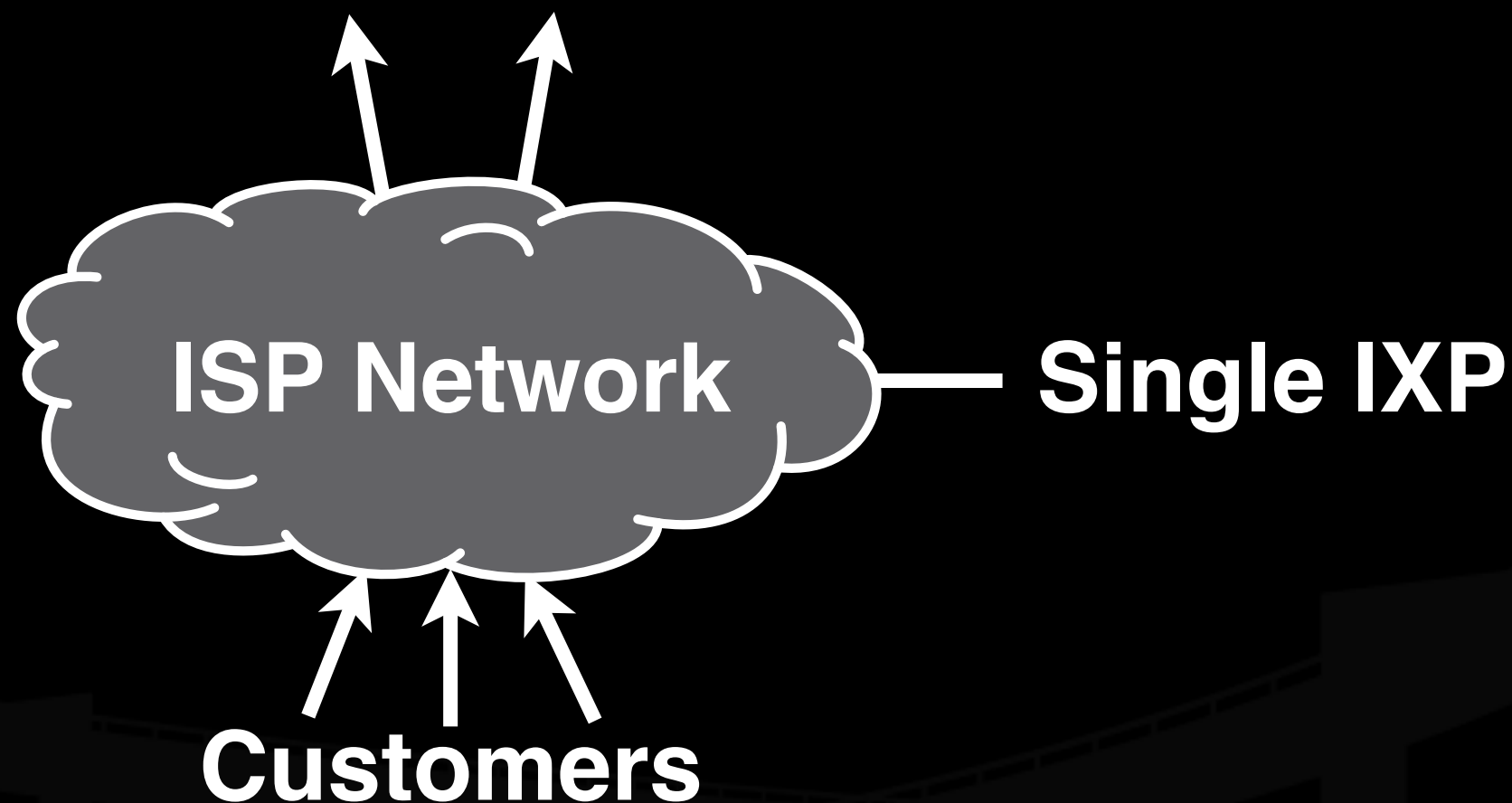




Ave Length = 4

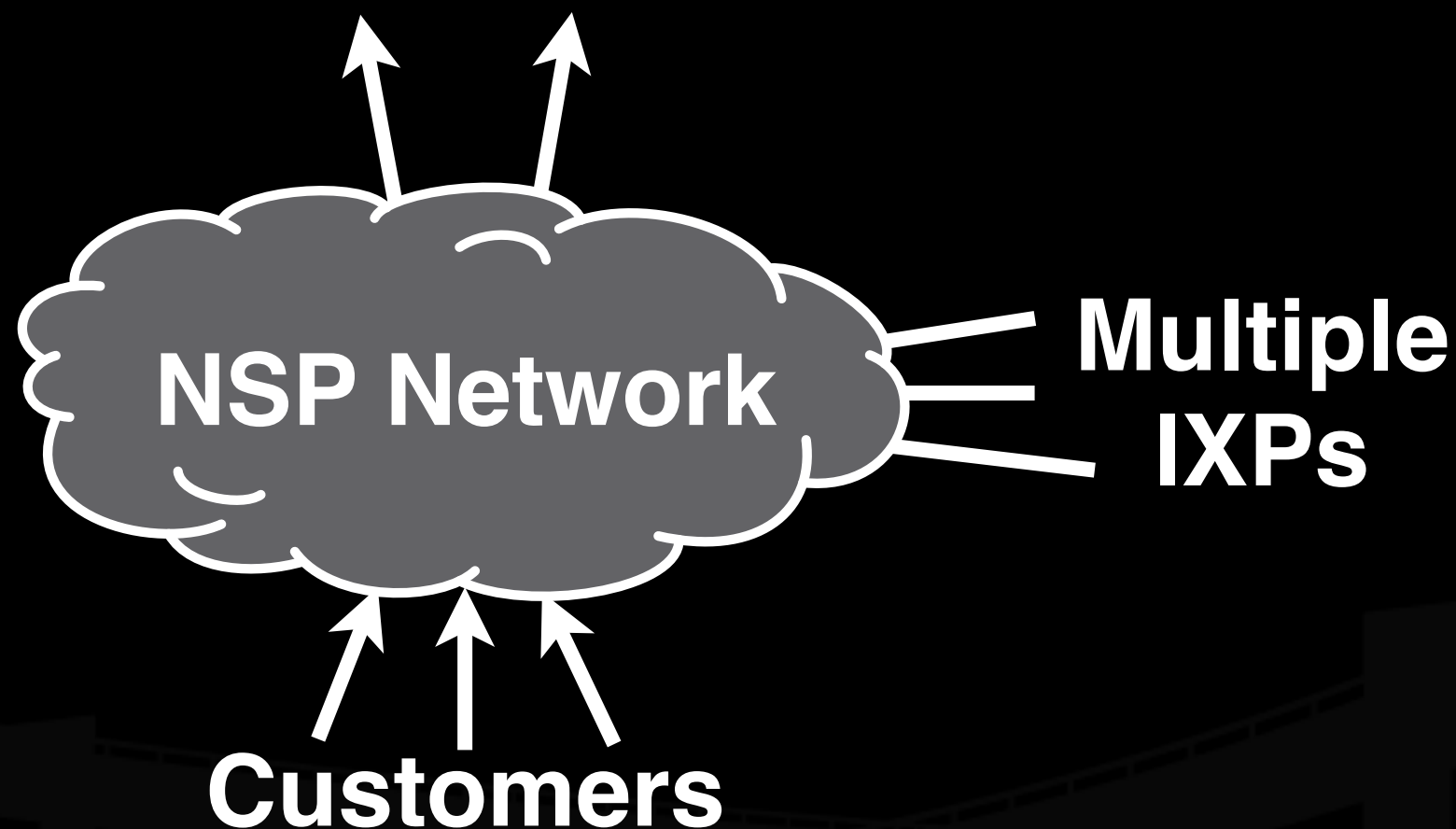
ISP Lifecycle: Local Peer

Redundant Transit Providers — IXP



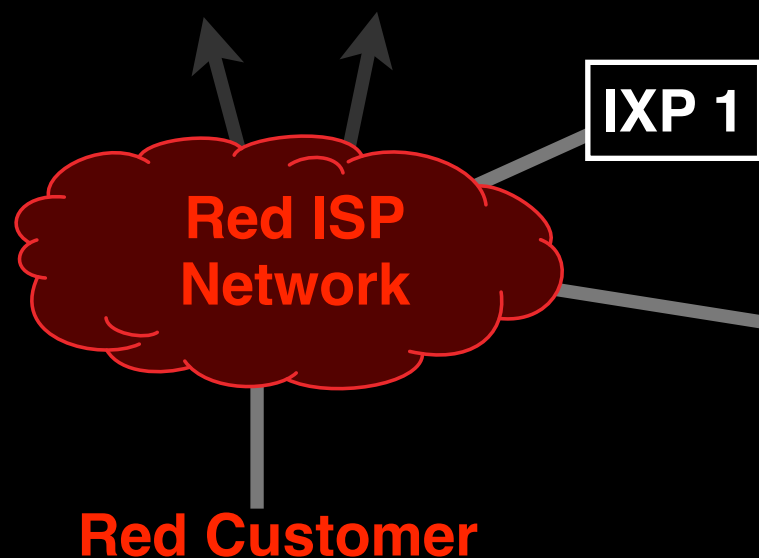
ISP Lifecycle: Backbone Network

Redundant Transit Providers — IXPs

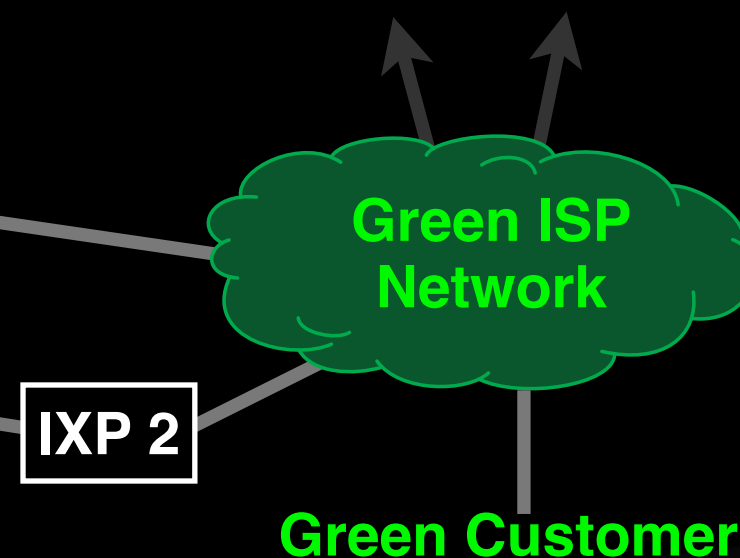


Hot Potato Routing

Redundant Transit Providers

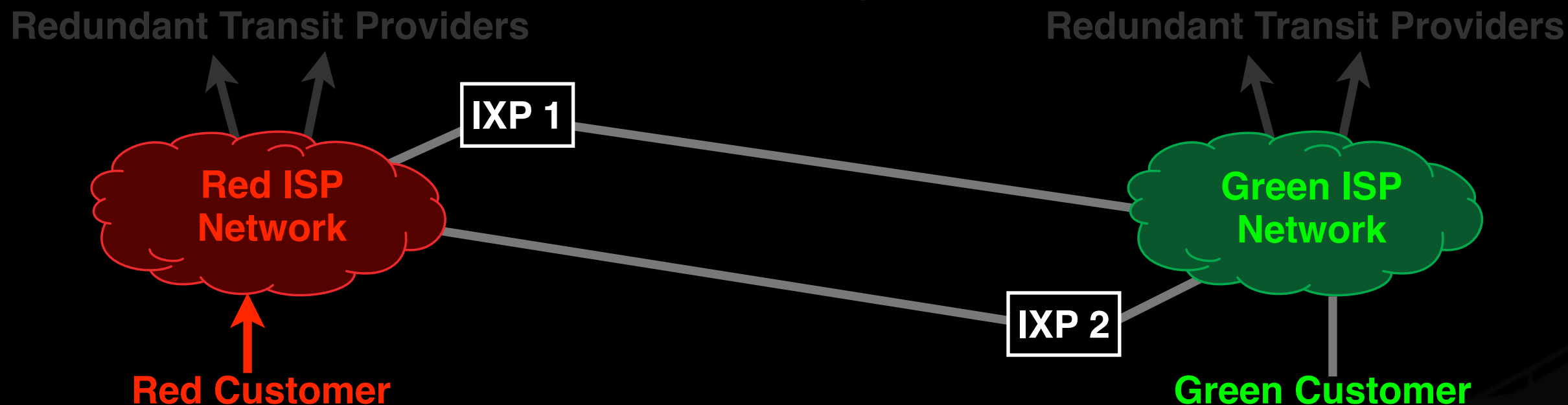


Redundant Transit Providers



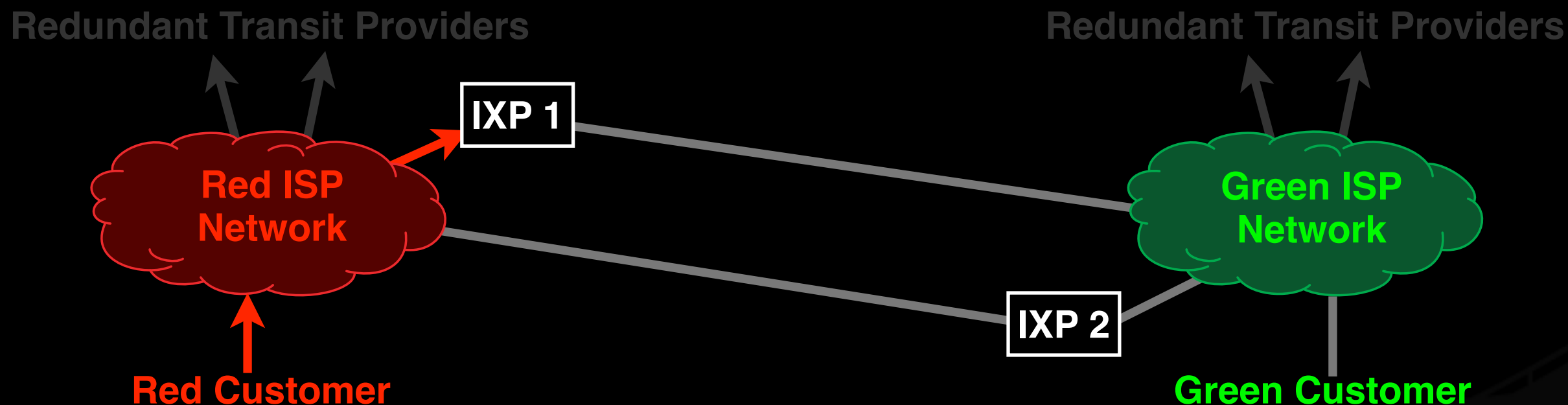
Hot Potato Routing

Red Customer sends to Green Customer via Red ISP



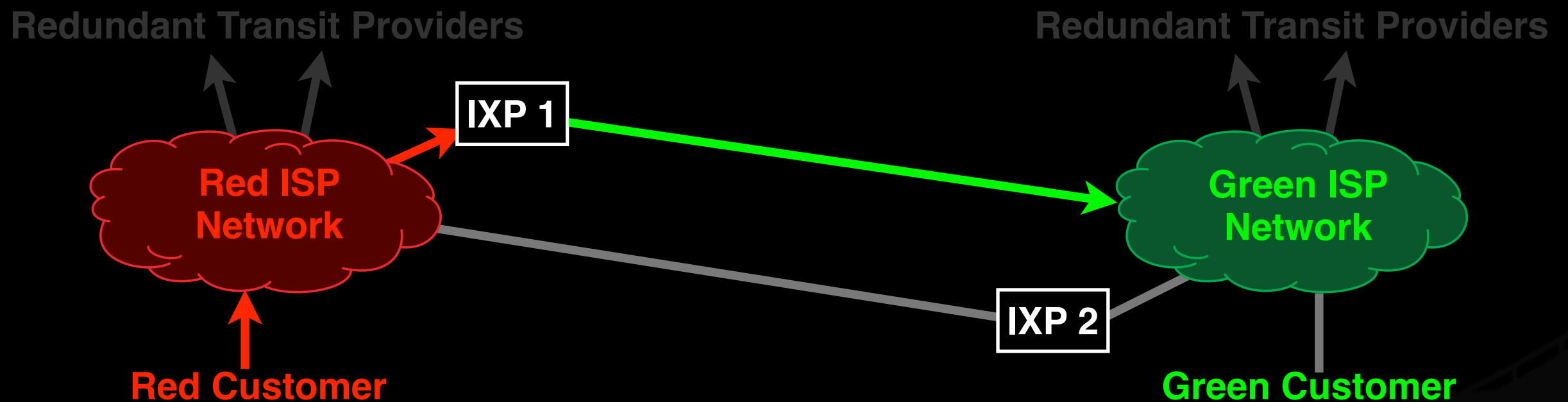
Hot Potato Routing

Red ISP delivers at *nearest* IXP



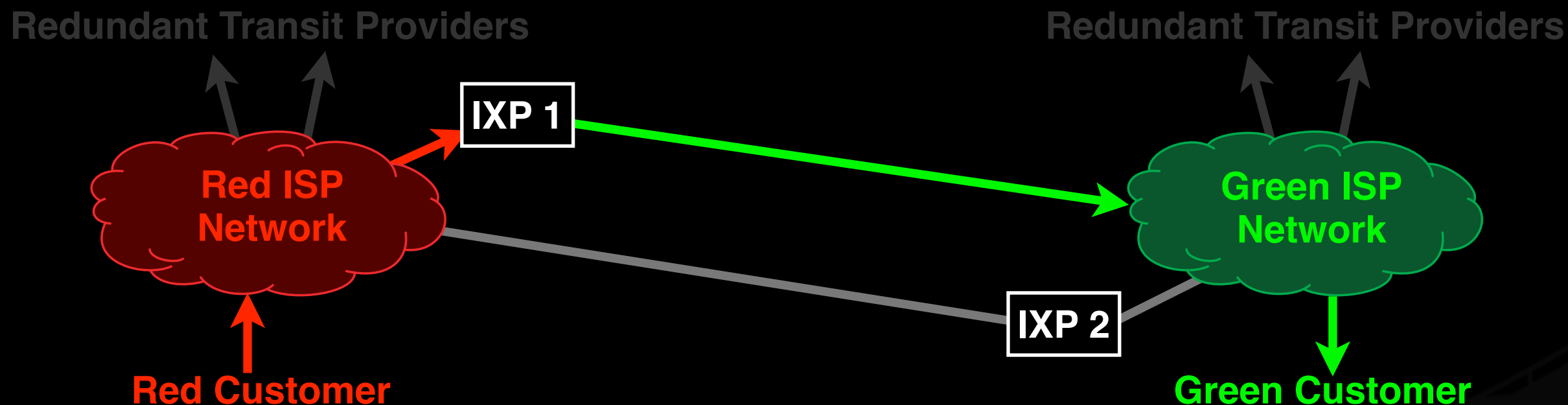
Hot Potato Routing

Green ISP backhauls from distant IXP



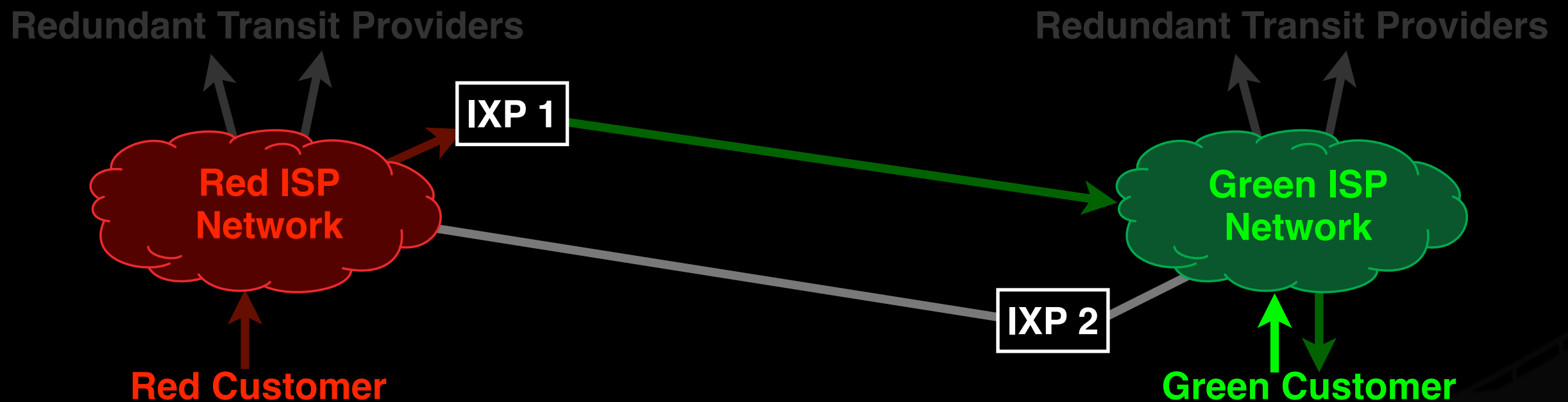
Hot Potato Routing

Green ISP delivers to Green Customer



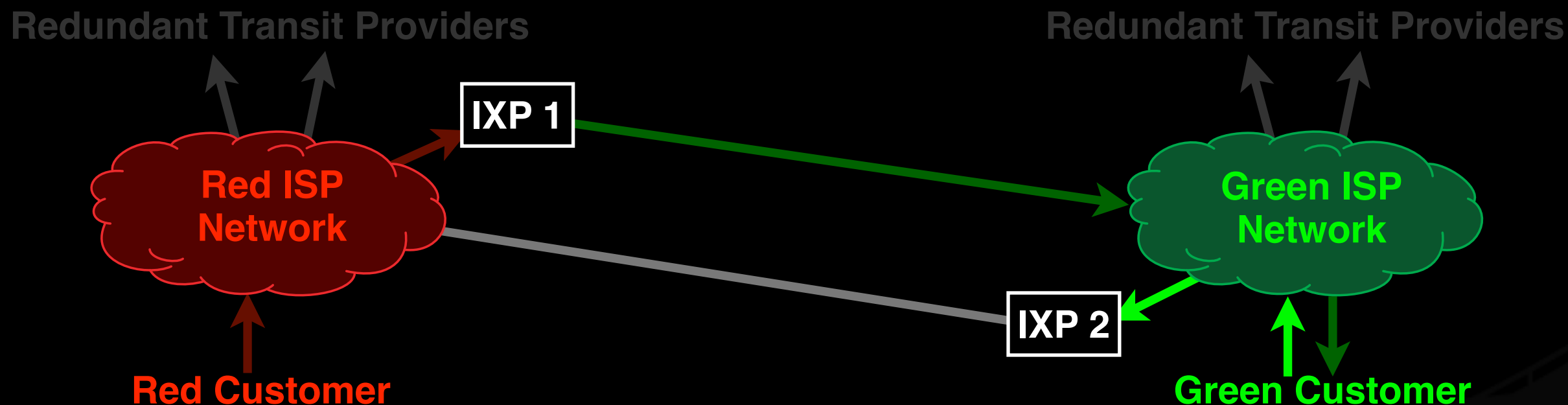
Hot Potato Routing

Green Customer replies via Green ISP



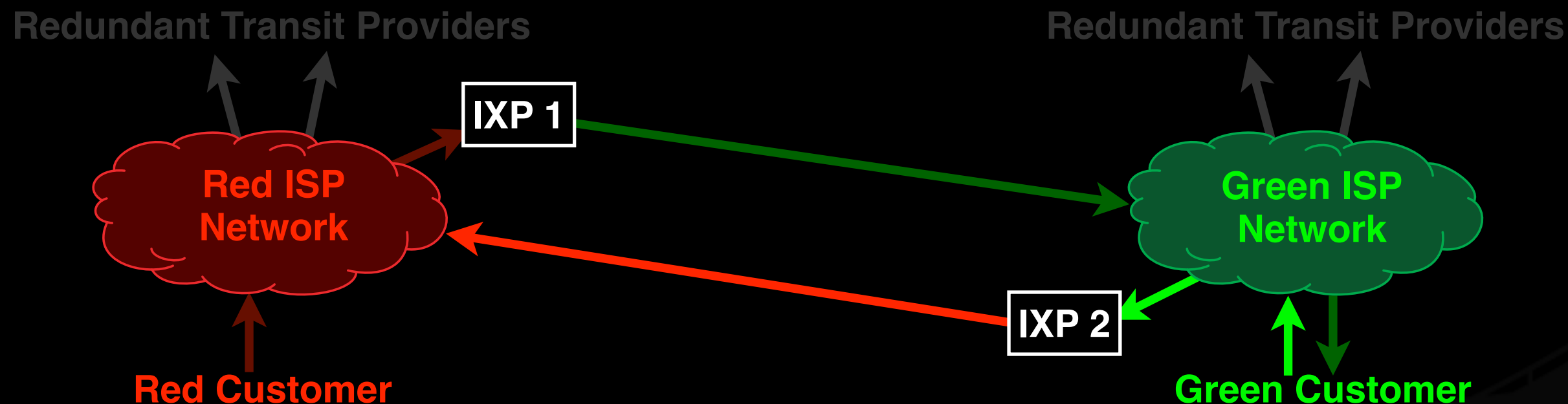
Hot Potato Routing

Green ISP delivers at nearest IXP



Hot Potato Routing

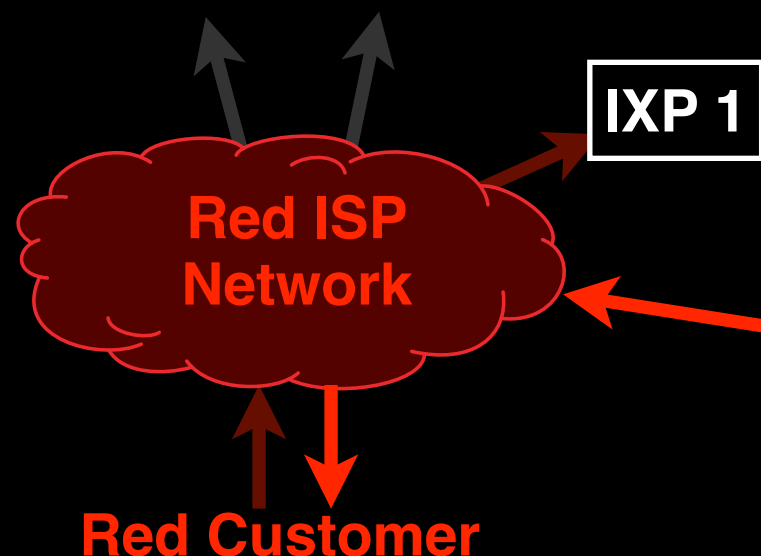
Red ISP backhauls from distant IXP



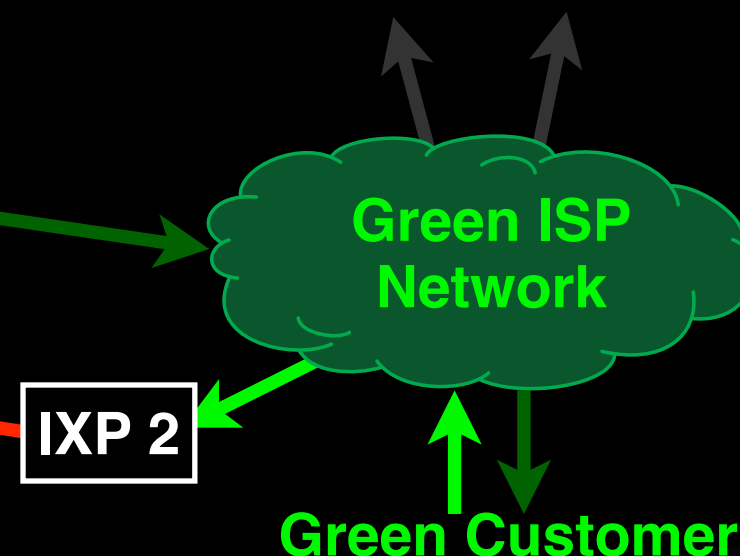
Hot Potato Routing

Red ISP delivers to Red Customer

Redundant Transit Providers



Redundant Transit Providers

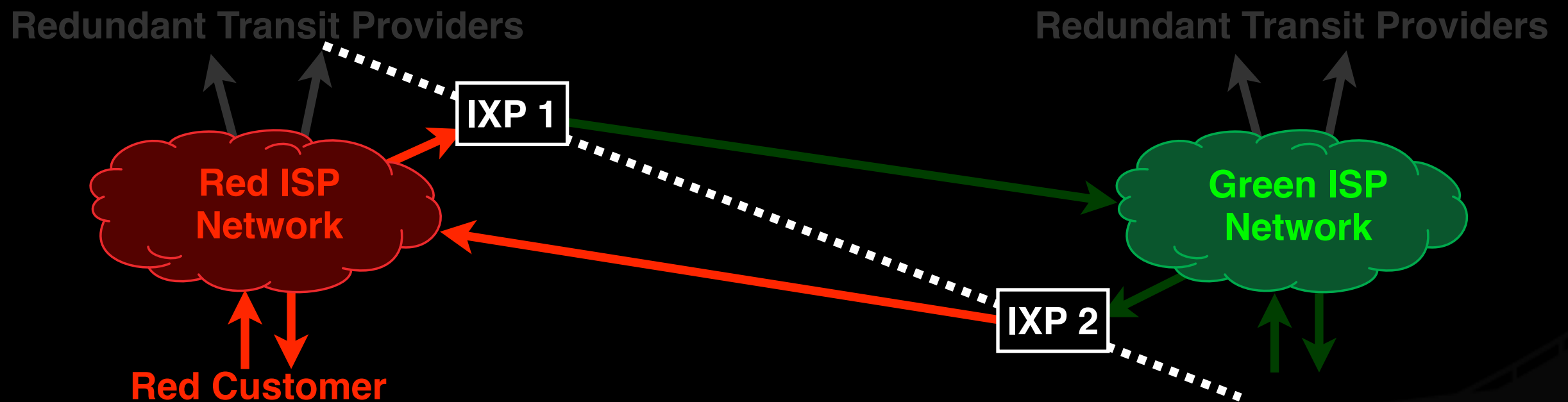


IXP 1

IXP 2

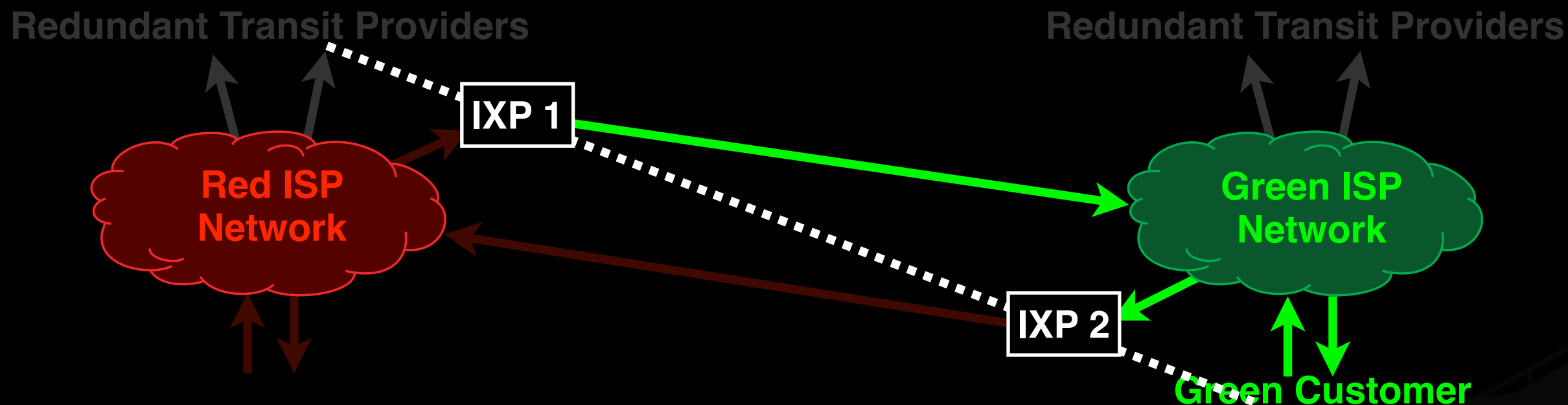
Hot Potato Routing

Red Network is responsible for its own costs



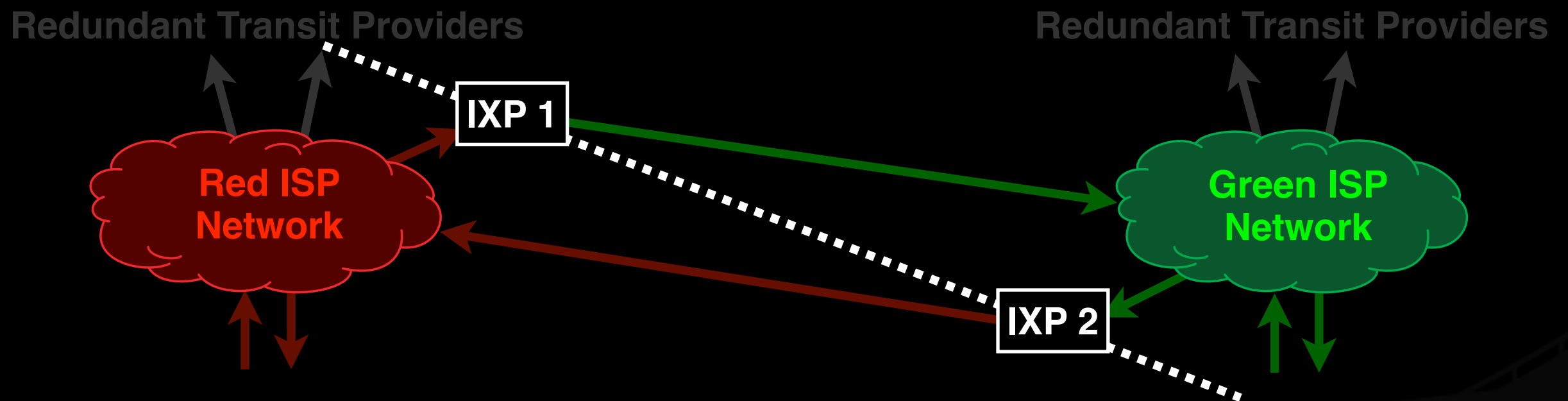
Hot Potato Routing

Green Network is responsible for its own costs



Hot Potato Routing

Symmetry: Fair sharing of costs



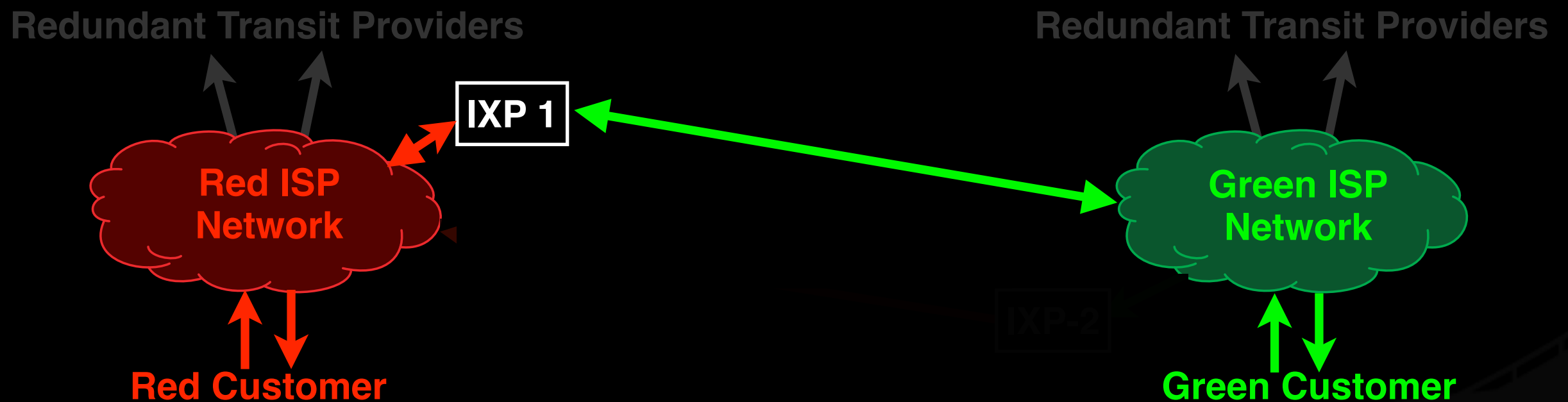
The efficiency of the Internet depends upon this principle:

For any two parties who wish to exchange traffic equitably, there must be a pair of exchanges, one near each party.

The Corollary:

Cities / countries / economies that have not yet built Internet Exchange Points disadvantage themselves, and export capital to cities / countries / economies that already have.

When there's no domestic IX...



...you are always on the “long” path!

speed * distance = cost

Why do we peer?

Cost reduction

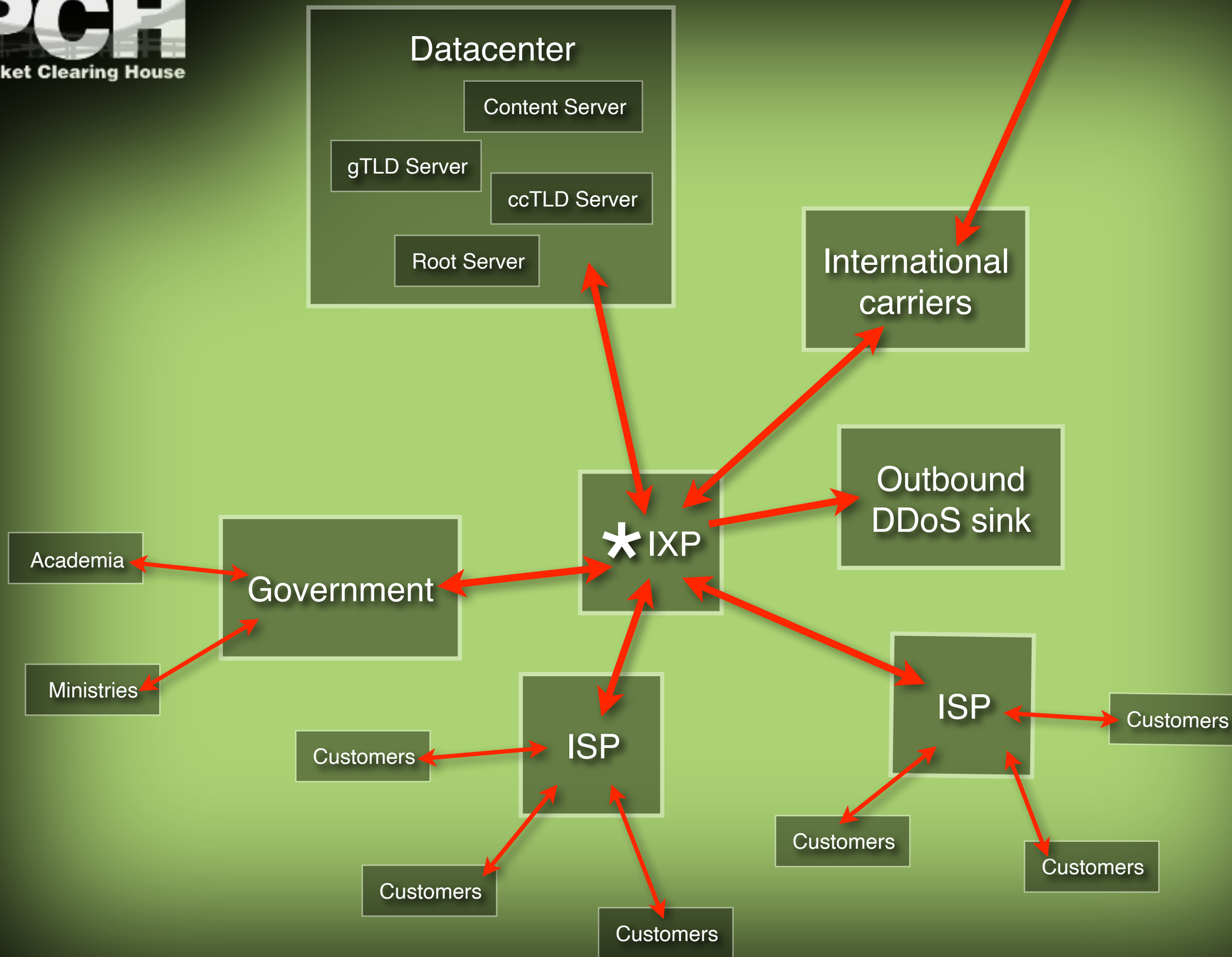
Economic tool

Performance

Sovereign Data

To not export capital !

Knowledge Economy



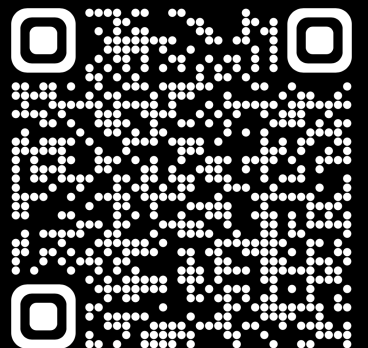
Policy Goals

- Promote interconnection in your country, and then the region.
- Promote interconnection from non-traditional network operators.

“The international nature of AMS-IX, with 80% of our customers coming from abroad, has attracted many international companies to establish themselves in Amsterdam, making our company part of the third mainport alongside the port of Rotterdam and Schiphol Airport. The strong internet connectivity acts as a magnet and is crucial for the Netherlands to maintain its leading position as a hub for Europe now and in the future”

- AMS-IX Annual Report 2023

99.998%*



*Source: <https://www.pch.net/resources/Papers/peering-survey/PCH-Peering-Survey-2021/PCH-Peering-Survey-2021.pdf>

Critical Infrastructure Checklist

- ✓ Domestic IXP. One per major city eventually.
- ✓ Your own ccTLD nameservers at domestic IXPs and major IXPs on the other side of your international circuits.
- ✓ Root nameservers domestically. Multiple when possible.
- ✓ DNSSEC sign your national ccTLD.
- ✓ Use DANE to bootstrap a national Certificate Authority.
- ✓ Neighbors' ccTLDs and other TLD nameservers of interest domestically, at your IXP, connected to your ISPs.
- ✓ Datacenters adjacent to your IXP.
- ✓ DDoS sinks on both sides of your international circuits.
- ✓ Redundant fiber paths both domestically and to major IXPs bordering the region.

Policy & Regulatory Checklist

- ✓ Avoid over-spending and gold-plating.
- ✓ Encourage international content to mirror at your IXP.
- ✓ Maintain a competitive domestic marketplace in all services. Regulate only constrained common goods. Use class licenses rather than individual licenses by default.
- ✓ Encourage your ISPs to do business in neighboring countries, and welcome their ISPs to do business in yours. Together you'll boot-strap into larger markets.
- ✓ Adopt or ratify the Council of Europe Convention on Cybercrime.
- ✓ Institute cybersecurity programs at all levels of your educational system.
- ✓ Be aware of and participate in Internet governance, don't let others speak in your stead, and don't get used as a disposable pawn in other people's fights.

Thanks!



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Policies that spur Digital and Economic Growth

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Enabling telecoms sector growth within the region

Goal: to be able to create/build/improve on new and existing telecoms policy and infrastructure, to allow the development and foster growth of new carriers; to promote competition in the region.

Restrictive telecoms regimes inhibit growth

Competition is the single key critical element to foster growth. eg. ZA situation went from 1 to 2 to 300+ telcos, and since liberalisation, capacities have grown ten thousand fold in 3 years.

(Broadband went from dial-up —> 512Kb/s —> 2Mb/s —> 40Mb/s —> 100Mb/s —> 1Gb/s)

Growth can only occur under favourable market conditions

“Open Access” telecoms network policies are needed allowing for:

Deregulated local loop (or an equivalent service)

Duct sharing policies

Fair/open access to infrastructure in neighbouring states

Fair/open access to landing stations

Licensing

Should not be necessary to license operators that are not reselling services in country.

Operators may wish to connect to a local IXP, or local business partner to facilitate business opportunities. If they don't have direct business-to-user relationships, then legal registration may be an impediment to operations.

Easy access to spectrum

While the region builds her fibre networks, easy access to spectrum to deploy and deliver high(er) speed networks is critical to growth. Wireless services are key, to fast and cheap deployments

Broadband policy

Broadband to the home/SOHO necessary for getting critical, commercial economies of scale into the network.

Mass influx of new entrants are not a threat to established networks.

Content Legislation

Permissive legal environment for the development and hosting of content locally.

Ideally, content hosting/delivery networks should not be prosecutable for content that is not explicitly “owned” by them, but may be available via their services.

Human Resources

National/Regional HR policies should be conducive to hiring and retaining staff.

Easy to obtain work permits for foreign staff.

Bilateral tax treaties with countries.

Regionalised training and capacity development (knowledge economy) workshops through organised systems such as NOGs.

Digital Taxation

Digital taxation policies should be flexible and innovative to spur growth of e-business which will have further ongoing benefit.

Reduction of taxation on communication equipment importation.

Business Conducive Environments

Having suppliers for infrastructural components in-country is critical to ensure active competition and quality of service that relate to service delivery.

- * competition/pricing
- * backups/spares

Procedures for cross border connectivity

Standardised processes and guidelines for performing cross border interconnections in an open and transparent manner.

Futurist policies to encourage growth

E-Government services should be made a priority, and localised within the environment. Government is an opportunity for large content provision and priority should be set to making this work, to encourage complementary content, and other enabling services (eg. local hosting / data centre builds)

Infrastructure Security

Globally: Support for work the likes of GCSC

Locally: We need to find systems and structures to address the issue of vandalism to protect infrastructural investments.

Thanks!



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OECD findings on the effect of the pandemic on Internet infrastructure

OECD findings on the effect of the pandemic on Internet infrastructure

“Since the start of the COVID-19 crisis, demand for broadband communication services has soared, with some operators experiencing as much as a 60% increase in Internet traffic compared to before the crisis.”

For many operators, this was the equivalent of experiencing six or eight months of normal growth, compressed into a period of two months.

OECD findings on the effect of the pandemic on Internet infrastructure

“Network operators and content providers have to date successfully maintained services and efficiently utilised pre-existing capacity, and in certain cases expanded this capacity.”

The planning horizon for network deployment is typically eighteen months. Capacity deployed in January of 2020 had been in planning and construction since July of 2018.

Networks are built to accommodate DDoS attacks, which greatly exceed legitimate customer traffic. It's that headroom that's being consumed.

OECD findings on the effect of the pandemic on Internet infrastructure

“Additional short term measures are important to further enhance network stability and resilience, and to reduce the digital divide: for example, ensuring access for network operators and content providers to communication equipment, datacentres, and mobility of technicians to customers’ homes.”

In order to minimise the impact with which we hit a capacity-exhaustion wall in 2021, we need to continue as much as possible in 2020 the work that was planned in the latter half of 2019, and we need to continue planning work to be completed in 2021.

OECD findings on the effect of the pandemic on Internet infrastructure

“Policy makers and regulators can alleviate congestion in mobile networks by releasing additional spectrum on a temporary basis, or by approving temporary commercial spectrum transactions between providers that put unused spectrum into service.”

The largest mobile operators are the ones most likely to be able to put additional capacity to immediate use, but allowing them to permanently claim spectrum acquired through a shortcut would be deleterious to competition and the public good.

OECD findings on the effect of the pandemic on Internet infrastructure

“In the medium term, regulators could stimulate broadband providers to deploy more fibre deeper into the networks and gradually phase out xDSL technologies, where possible, and alleviate administrative burdens to ease network deployment.”

The time for copper infrastructure is long gone, and no new money should be spent on prolonging its existence, since copper infrastructure, at this point, is principally a means of creating artificial scarcity.

Expert Recommendations and Insights

“This is the end of enterprise VPN access from home offices.”

As the number of employees working from home increases from a handful of senior executives to a majority of knowledge-workers, support costs and risks associated with allowing backdoorable home networks privileged access to enterprise LANs and services will become unsupportably large.

Instead, enterprises will need to tighten up individual endpoint security.

Expert Recommendations and Insights

“Regulators should no longer allow asymmetric constraint of upstream bandwidth.”

Internet networks are naturally symmetric. But many cable television companies enjoyed close relationships with regulators, and were allowed to artificially constrain customers' bandwidth in the upstream direction, as a way of disincentivizing file sharing and content publishing by customers, since that competes with the video content which cable companies feel that they should be able to violate network neutrality to push on customers.

Expert Recommendations and Insights

“High-capacity peering links are producing all of the needed extra bandwidth to satisfy the new demand. Essentially none of it is coming from transit.”

Because peering connections at IXPs are a flat sunk cost, capacities are high and increased utilisation creates more value. By comparison, transit connections are typically small, run full, and cost more when more capacity is needed, so there's no additional value to be had from them when demand picks up.

Expert Recommendations and Insights

“Who repairs critical infrastructure when private sector employees are sick or otherwise immobilised? This is an opportunity for the public sector to provide a safety net for the private sector.”

Expert Recommendations and Insights

“Border closings and flight route cancellations came at the same time that remote hands became more difficult to procure, and supply-chains failed. ICT import duty waivers should have been put in place.”

Expert Recommendations and Insights

“The combination of high-security jobs suddenly being work-from-home and organisations failing over to overseas cloud services to replace face-to-face or on-site interaction made plain that closed-source and cloud services should never have been allowed for government, military, or critical infrastructure. Self-hosted open-source is the only combination that you can depend on for secure or critical roles.”

Thanks!



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Total Internet Security of a Country

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.ccTLD

Managed within a country

At least one server housed within your borders

Under local jurisdiction

DNSSEC signed

Local ISPs using DNSSEC validation ?

DNS & Roots

Locally hosted copy of ccTLD

Locally hosted copy of _other_ TLDs ?

Locally hosted DNS Roots?

IXP

Good: At least one IXP per country.

Better: At least one IXP per major city/
economic centre

Datacentres

Competing carrier neutral data centres

Competitive local fibre

This might not seem obvious at first, but natural user predilection is to choose the fastest path to a resource.

CERT

Co-ordinating Internet security response, and liaison between government, and industry.

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