PREPARE TODAY FOR TOMORROW'S IPv6 WORLD

Sustaining business continuity in a dual-protocol environment

Business white paper

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Executive summary

IPv6 represents one of the most significant technology changes in the history of the Internet. With the growing number of online users around the world and the proliferation of smart devices, IPv4 exhaustion will become a major information and communications technology issue over the next three years. Any organization that relies on the Internet to any extent must be prepared to support IPv4's successor, IPv6.

This next-generation protocol is the key to continued growth of the Internet, solving the problem of IPv4 address depletion and providing seamless connectivity. IPv6 also offers a number of improvements over IPv4 that deliver business and technical advantages.

Because all existing IPv4-based infrastructures will continue to work after the last IPv4 address is issued, enterprises may be tempted to put off transitioning to IPv6. Postponing the inevitable, however, can put an enterprise at a competitive disadvantage. As more and more customers operate in an IPv6 world, companies supporting only IPv4 risk being shut out of high-growth markets because they are unable to reach—or be reached by—these customers. To sustain seamless, pervasive connectivity with consumers, partners, and businesses around the world, organizations need to be able to communicate in a dual-protocol environment that will ultimately become IPv6 only.

The transition process for allowing IPv4 and IPv6 systems to communicate requires careful planning to keep the end-to-end model for Internet applications such as those used for e-commerce or business-to-business (B2B) communications from breaking down. To minimize the expense and impact of the transition, a phased deployment is recommended.

This paper looks at IPv6 drivers, the business benefits of IPv6, the need for a well-managed transition, and guidelines for achieving both short- and long-term goals.

Dawn of a second revolution in network usage

When IPv4 became the standard Internet protocol in the 1980s, its 4 billion–address maximum seemed more than adequate. As the development of the World Wide Web and global implementation of email transformed the Internet from a research tool to a commercialized network in the 1990s, however, traffic doubled each year[1]—and the consumption of IP addresses skyrocketed.

Today the world is at the dawn of a second revolution in network usage that is consuming addresses more rapaciously than ever. Uneven distribution of IPv4 addresses, with the majority allocated to the Western world, is compounding the problem. Populous countries with expanding economies, such as China and India, are already feeling the impact of IPv4 address exhaustion.

The dwindling availability of IPv4 addresses is due to a combination of factors:

- **Always-on connectivity**. The widespread penetration of broadband Internet access through DSL and cable modems that are rarely turned off increases the demand for IP addresses.

- **Proliferation of mobile devices**. The number of cellular connectivity–enabled consumer electronics devices shipped doubled in 2010 and is forecast to reach 39 million units in 2011.[2] These devices include mobile PCs, Internet tablets, and smartphones, for all of which Internet connectivity—and therefore an IP address—is a fundamental part of the user experience.

- **Expansion of networked consumer appliances**. Internet-enabled appliances, each requiring its own IP address, offer convenience through remote management or Web access. These range from LED light bulbs that can be monitored, managed, and controlled from a smartphone or PC to microwaves capable of downloading recipes while doubling as Web browsers.

- **Internet demographics**. As more of the world's population goes online, the pressure on IPv4 addresses grows. The number of people with Internet access in Brazil, Russia, China, India, and Indonesia is expected to reach 1.2 billion by 2015.[3] Less than 25 percent of Asia's estimated 3.8 billion people currently have Internet connections, compared to North America's 78 percent penetration rate.[4] According to The Internet Society, the total number of devices accessing the Internet will increase from 1.6 billion in 2009 to more than 2.7 billion by 2013.[5]

- **Virtualization and cloud computing**. Each user session or program on a virtual machine receives a public IP address from a configuration protocol server, which must store enough IP addresses for all sessions or programs. Virtualization is a core enabling technology for cloud-based services.

[1] K.G. Coffman and A.M. Odlyzko, The size and growth rate of the Internet, AT&T Labs, October 2, 1998. www.dtc.umn.edu/~odlyzko/doc/internet.size.pdf

[2] Emerging Wireless Consumer Devices, M&M Research Series, Berg Insights, February 2011.

[3] The Internet's New Billion: Digital Consumers in Brazil, Russia, India, China, and Indonesia, Boston Consulting Group, September 2010. www.bcg.com/documents/file58645.pdf

[4] Internet Usage Statistics, March 31, 2011. www.internetworldstats.com/stats.htm

[5] IPv6 Global Deployment, The Internet Society, January 24, 2011. http://ipv6.isoc.ph/Mat_Ford-slides.pdf

IPv4 address exhaustion: fact or fiction?

The last blocks of IPv4 addresses were allocated to the five regional Internet registries in a public ceremony on February 3, 2011, that marked the beginning of the end of IPv4 as the default Internet protocol standard. Except for a limited number of addresses held in reserve to facilitate the transition to IPv6, the Asia Pacific registry exhausted its regional pool on April 15, 2011. At current rates of consumption, most industry observers expect Europe to run out by the end of 2011 and the registry responsible for the U.S. and Canada to deplete its supply by early 2012, if not sooner. Latin America and the Caribbean will run out sometime in 2014, and Africa in 2016.

Of course, reaching those depletion dates will not mean the end is at hand for IPv4. A number of mitigating techniques, most of which involve complex translation schemes, have been developed in an attempt to further extend the protocol's life. As a U.S. government report notes, however, "While these (fixes) provide partial mitigation for IPv4 exhaustion, they are not a long-term solution, increase network costs, and merely postpone some of the consequences of address exhaustion without solving the underlying problem. Some of these fixes break end-to-end connectivity, impairing innovation and hampering applications, degrading network performance, and resulting in an inferior version of the Internet."[6]

Some industry watchers foresee the rise of an IPv4 "gray market," with companies selling or auctioning off underutilized address blocks to other enterprises. In a widely publicized transaction for example, Microsoft paid $7.5 million USD, or more than $11 each, to purchase 666,624 IPv4 addresses from Nortel.[7]

Bottom line: IPv4 address exhaustion is real. While the Internet will continue to function even after all registries run out of IPv4 addresses, sustaining its explosive growth requires a new Internet protocol. As IPv4 exhaustion becomes a major information and communications technology issue, organizations must be prepared to support IPv6.

The next-generation Internet

Anticipating the depletion of IPv4 addresses, the Internet Engineering Task Force (IETF) finalized IPv6 in the late 1990s. (The number "5" had already been used to designate a protocol created for the experimental transmission of voice, video, and distributed simulation.) The IETF, which is responsible for developing the technical standards that make the Internet work, drew on its experience with IPv4 to create a new protocol that would accommodate the dramatic growth of the Internet and offer capabilities not available with IPv4:

- **Unlimited addresses**—IPv6 allows for more than 340 undecillion (340 followed by 36 zeros) addresses. Because of the vast number of IPv6 addresses available, virtually everything can be Internet-enabled. Devices can be easily networked for inventory tracking, performance-based maintenance scheduling, and instrument monitoring over an IP rather than proprietary control system network.

- **Plug and play for ease of management**—IPv6's stateless auto-configuration enables new devices to be added to the network without any further action on the part of IT staff. Just being physically connected to the network will enable a machine to configure itself automatically and communicate with other machines.

- **Enhanced mobility**—Because IPv6 facilitates the deployment of online mobile communications by supporting seamless and continuous Internet connectivity, a device can have an IP address that is reachable no matter where the user may be.

- **Built-in multicasting**—IPv6 advances the art of multicasting to meet the growing demand for high-bandwidth multimedia applications. Multicasting also makes it easier to set up automatic IP failover for replication servers, helping to ensure high availability in fault-tolerant environments.

- **End-to-end services and applications**—IPv6 will ultimately eliminate the need to deploy and support network address translation (NAT) devices to conserve public Internet address space, saving money and simplifying network administration.

- **Higher performance**—Simplified header processing in IPv6 allows for more efficient packet handling.

- **Better support for QoS**—Inclusion of levels of assured service enables enhanced quality of service support for time-sensitive applications such as VOIP with IPv6, eliminating the latency, jitter, echo, and other quality issues experienced on IPv4 networks.

- **Enhanced security**—IPv6's built-in IPsec support allows devices to securely authenticate remote nodes and encrypt communications with them for true end-to-end security.

Moving to IPv6 also presents an opportunity to rethink how technology can spark business innovation. According to a recent Forrester Research report, the "inevitable transition to IPv6 is actually a good thing" because enterprises can use it as a "foundation for a richer and stronger set of infrastructure services…. It's about remaining relevant and competitive. Technology that enables the real-time, dynamic flow of information is critical for top- and bottom-line growth."[8]

[6] Potential Impacts on Communications from IPv4 Exhaustion & IPv6 Transition, Federal Communications Commission, December 2010. http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-303870A1.pdf

[7] Microsoft pays Nortel $7.5 million for IPv4 addresses, NetworkWorld, March 24, 2011. www.networkworld.com/community/blog/microsoft-pays-nortel-75-million-ipv4-address

[8] Opening New Doors with IPv6, Forrester Research, Inc., February 18, 2011.

IPv6 is here today

Internet service providers—from the largest ISPs to family-owned independents such as Vermont's VTel in the United States[9]—are rolling out IPv6 networks. As Forrester observes, "Asia and South America, with their population and rapid economic gains, were assumed to have the largest amount of IPv6 infrastructure today, but North America and Europe are actually ahead."[10] France's ISP Free, NTT, Hurricane Electric, Global Crossing, Level 3 Communications, and TATA Communications were among the first to upgrade their infrastructures and offer IPv6 services.

A number of governments around the world have issued IPv6 deployment mandates or roadmaps, and China has created the world's largest IPv6 network. Google™, Yahoo, CNN, YouTube, and others are providing IPv6 content. The Verizon Wireless 4G LTE network has IPv6 built in, with the requirement that all LTE devices be IPv6-capable.

In an event known as "World IPv6 Day," major websites and other industry players participated in a successful global-scale test of IPv6 on June 8, 2011.

Despite all this IPv6 activity, enterprises may be unaware of the need to move to the new protocol or feel no sense of urgency to make the transition. Many believe that an IPv6-only world is not on the immediate horizon. Therefore, the natural inclination is to postpone action until it appears there is no choice. The fallacy in this position is that maintaining IPv4-only communications can put enterprises at a competitive disadvantage. Seamless, pervasive connectivity is an integral part of doing business today. Websites, customer portals, and online services must be available to users regardless of their IP address.

As Forrester Research notes, "There is a large, untapped customer base in Asia that connects with IPv6-only devices and can only communicate with IPv6 hosts."[11] Companies able to tap into that base stand to gain a clear competitive edge.

The IPv6 transformation journey

The vast majority of personal computers, operating systems, switches, routers, content providers, carriers, and Internet service providers (ISPs) support native IPv6 today at no extra cost, which makes it possible to install a new network based on IPv6.

However, enterprises typically purchased and configured their Internet and internal networking components to support IPv4 traffic only. While most network gear will be software upgradable, some may need to be replaced to add support for IPv6. Even if the capabilities to operate in a dual network configuration exist, with equipment supporting both IPv4 and IPv6 traffic, additional planning steps and architecture design will most likely be required. Management systems and security systems that can support both environments are necessary. All mission-critical applications, including voice, rely on Internet protocol and IP addressing. Enterprises must also verify that the applications they use are IPv6-enabled; most have been tested only with IPv4.

Because IPv4 and IPv6 will coexist for some time, a phased deployment is recommended to minimize the impact of the transition and keep costs manageable. Recognizing that IPv4 and IPv6 will run parallel to each other for the foreseeable future, IETF established three standard transition mechanisms:

- **Dual-stack**, which provides support for both protocols on the same device to allow for communications with both IPv4-only and IPv6-only nodes

- **Tunneling**, which encapsulates IPv6 packets in IPv4 headers to allow them to be routed via an IPv4 network

- **Translation** between IPv4 and IPv6

Each of these techniques has advantages and trade-offs. The optimal solution will depend on a variety of factors, including the enterprise's current environment and long-term goals. It may also encompass all three transition mechanisms. It is important to understand that one method does not fit all.

[9] VTel rolls out IPv6 on its network, June 4, 2010. www.vermontel.com/news/71-ipv6

[10] Opening New Doors with IPv6, Forrester Research, Inc., February 18, 2011.

[11] Opening New Doors with IPv6, Forrester Research, Inc., February 18, 2011.

The following tips can help ensure a smooth transition to IPv6:

1. Start sooner rather than later.
Enterprises typically underestimate the time and effort required to add IPv6 to their infrastructure. Proper planning is essential, as IPv6 touches virtually every device in and on the network—including servers, PCs, and printers. Understanding the enterprise application landscape is also important. Enabling IPv6 on a system does not necessarily enable applications to use IPv6. While most modern applications are IP version–agnostic, older applications (or IP version–dependent applications) will need to be upgraded to use IPv6 as a transport protocol.

Because the transition is a multi-year process, it's important to begin the IPv6 journey as quickly as possible. Waiting to make the move won't make it any easier— and can actually increase the challenge. As IPv6 becomes more widely deployed, enterprises may find themselves in the position of having to make changes quickly without adequate time for assessment or strategizing.

2. Establish a joint business–IT task force.
IPv6 deployment is a multifaceted undertaking that affects more than the technology infrastructure. Business processes—and therefore, business continuity—are at stake. Successful deployment demands active involvement of a cross-section of business and IT functions. A governance model with executive sponsorship and participation of business and IT leaders is essential for addressing all aspects of the deployment. A network-centric-only approach is inadequate.

3. Understand the current environment—and the vision for the future.
Use IPv6 transformation as an opportunity to assess long-term business goals and how IPv6 will help get there. Can IPv6 revolutionize your supply chain? Streamline logistics? Will you use it to improve communications and allow real-time collaboration among customers, vendors, and internal personnel? Will it open new business opportunities? Are there new revenue streams you can capitalize on from digital services? Can you provide new customized experiences for users? Knowing where you are today and where you want to be should drive IPv6 execution.

4. Plan for success.
Determining the most appropriate transition plan depends on many factors, including short- and long-term business goals. With proper planning, organizations can map business needs to IPv6 transformation in order to grow with the technology. Develop a roadmap that highlights how technologies and business processes must evolve to support the transition to IPv6. Detailed planning enables organizations to avoid pitfalls that could undermine the user experience and be counterproductive.

5. Leverage available services.
IT staffs at most organizations are already stretched to the limit. Yet the transition to IPv6 is highly labor-intensive. To get the transition off to the best possible start, consider the use of consulting services to identify the optimal mechanisms and develop an IPv6 roadmap. Working with consultants can help get enterprises through the complexities of the transition with minimal disruption.

6. Bring IT staff up to speed.
A properly trained staff is critical for an effective transition to a dual-protocol network. In addition to network engineers and architects, system administrators, application developers, test engineers, and help-desk staff all need IPv6-specific training. Training typically accounts for the bulk of transition costs.

7. Don't neglect security.
Security needs to be in place before any IPv6 function is turned on. Firewalls may need replacement or reconfiguration to recognize IPv6 traffic. Even though IPv6's built-in IPSec offers enhanced end-to-end security to protect communications over the Internet, don't assume that all applications will utilize it.

Many operating systems are shipping with IPv6 enabled and preconfigured to tunnel out of the network, which can create unknown internal and external security holes in an existing environment. In essence, IPv6 is arriving "by stealth" in enterprises with little or no planning from an IT or security perspective. Misconfigurations, whether done unintentionally by users or administrators or stemming from malicious attacks on the network, pose a real threat to risk management and business continuity.

8. Incorporate IPv6 within the overall IT plan.
The cost of an IPv6-enabled infrastructure can be relatively small if the transition is part of a broader IT roadmap that leverages regular technology refresh cycles. For many enterprises, the technical ecosystem is already in place. All major operating systems are shipping with IPv6, which is often enabled by default. Network equipment vendors have been producing IPv6-capable gear for some time, so the routers and switches deployed through normal network refresh cycles may be ready for the new protocol.

Conclusion

The Internet is at an inflection point. Urgency centering on IPv6 is being driven by the exhaustion of IPv4 addresses, which has already occurred in Asia Pacific and is imminent in other regions. IPv6 holds the key to continued growth of the Internet and pervasive connectivity, which is in effect the "killer app" for the new protocol.

As a result, the transition to IPv6 is inevitable for any organization. Organizations need to be sure that customers as well as business partners can find them online. However, IPv6 implications extend well beyond the public networks. All mission-critical applications—including voice—rely on Internet Protocol and IP addressing.

To be sure of having adequate time to plan and allow for a phased deployment, enterprises need to start today. Postponing action until the widespread adoption of IPv6 puts an enterprise at risk of losing business to competitors who are able to "talk" IPv6.

Because every organization is different, the optimal approach for transitioning to IPv6 will vary. Enterprises may find that working with experienced consultants can help them bridge the knowledge gap and facilitate the design of a roadmap and a deployment strategy to meet their unique requirements.

The following recommendations help ensure a successful transition:

1. If you haven't already done so, start your IPv6 plan today.

2. Determine your in-house readiness and capabilities for a move to a dual IPv4/IPv6 world.

3. Enlist the help of an IPv6 partner who can assist with all stages of the migration.

4. Make sure your IT staff is trained on IPv6.

5. Address potential security issues.

6. Incorporate IPv6 within your overall IT plan.

Embracing the next-generation Internet not only sustains business continuity in a dual-protocol world, but also opens the door to opportunities for innovative technologies and enhanced collaboration that can improve the bottom line.

Appendix: HP IPv6 services

HP offers a full suite of consulting and implementation services for IPv6:

- **IPv6 Transformation Experience Workshop**—a highly interactive workshop for building a roadmap for transitioning to IPv6

- **IPv6 Readiness Assessment**—data collection and analysis to assess the current state of IPv6 in the environment; project hardware upgrades; and identify areas of immediate concern, including security

- **IPv6 Architecture and Design**—for developing a detailed architecture, along with a logical and physical network design, to support specific computing and business requirements; design documentation can include a recommended network topology, a network management solution, a bill of materials, carrier services, and detailed implementation design specifications

    - **IPv6 Web Start Service**—leverages leading IPv6 gateway technology and industry best practices to design and deploy a gateway solution that addresses an urgent need to IPv6-enable an IPv4-only website while planning an enterprise-wide transition

- **IPv6 Transition Service**—addresses IPv6 transition fundamentals, access and connectivity management, Domain Name System planning, routing and IP address management, product compliance, security considerations and planning, applications and services, operational impact, and IPv6 transition mechanisms

- **IPv6 Integration Service**—includes multivendor product procurement, cabling implementation, project management, staging and distribution, installation and configuration, integration, pilot and test, acceptance, training, and release to production
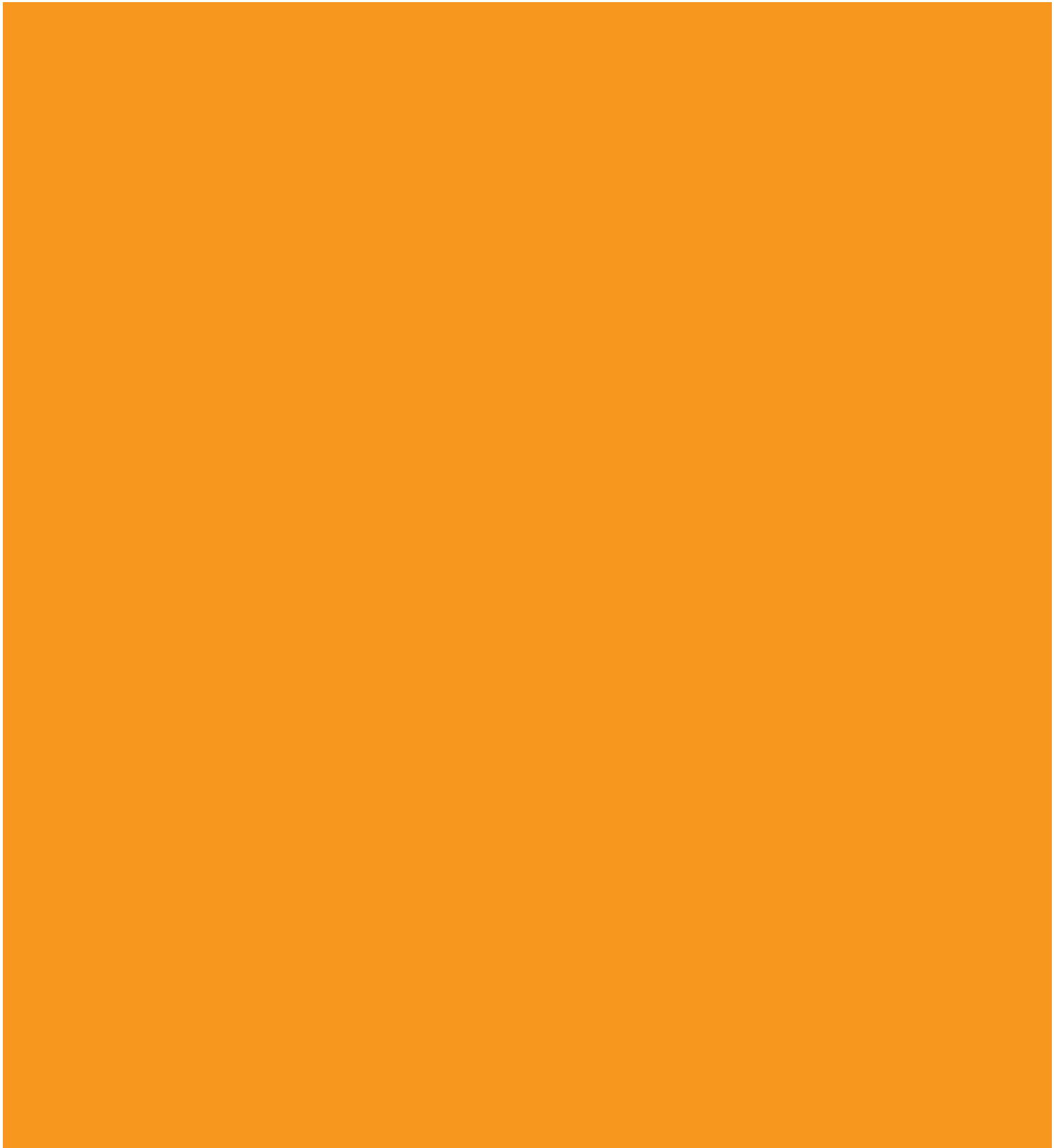
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