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# The Internet Way of Networking

An Introduction to the Internet, and the  
Internet Impact Assessment Toolkit

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The Internet is a network of over eighty thousand interconnected independent networks.

It works really well.


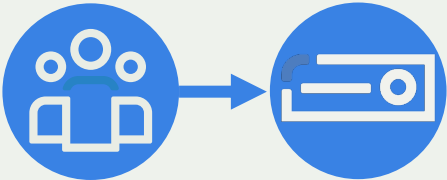
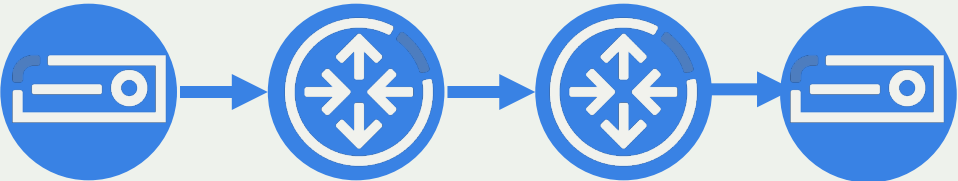



But there's a lot more to the story of both  
how and why it works ...







# How the Internet Works: Communicating over the Internet

What do we need to access a website from anywhere in the world?

- A location to send it to. 
- A human readable way to tell the destination to the system 
- A route to get the email to its destination. 
- A way to transport the email along the route to the destination of our choice. 

# Explaining the Internet through the Postal System

Task	Postal System (Centralized)	Internet Protocol (Decentralized)
<b>Location</b> 	<p>Zip or postal codes provide a numerical representation of a physical place. USTTI's Zip code: 20036-4131</p> <p>[200]    [36]                    [41]                    [31]</p> <p>↓           ↓                    ↓                    ↓</p> <p>[DC] [Delivery Area] [Connecticut Ave] [Connecticut Building]</p>	<p>IP addresses provide a numerical representation of a server connected the Internet. USTTI.org: 173.231.216.225</p> <p>[173.231]                    [216]                    [225]</p> <p>↓                    ↓                    ↓</p> <p>Network                    Subnetwork                    Server</p>
<b>Human readable destination</b> 	<p>Street addresses provide a human readable representation of a physical place and correspond with zip/postal codes.</p> <p>1150 Connecticut Avenue, NW, Suite 702 Washington, DC 20036</p>	<p>Domain names provide a human readable representation of places on the Internet and correspond with IP addresses.</p> <p><a href="https://www.ustti.org/">https://www.ustti.org/</a></p>
<b>Routing</b> 	<p>Using the zip/postal code, sorting facilities send mail to other facilities closer to the destination and becoming more local in covered area. Mail can go on many different roads or via different vehicles and still reach the next facility.</p>	<p>Using the IP address as the destination, networks use routing protocols to route the data from one network to another until it reaches the destination.</p>
<b>Transportation</b> 	<p>Mail is transported in standardized envelopes or packages by vehicles to their destination. These have the destination and sender's addresses written on them.</p>	<p>Using the TCP/IP protocol. Data is sent in "packets" across networks to their destination. The packet has the destination and sender's IP addresses.</p>

# Important Aspect of Internet Protocols

- Internet protocols are developed by the Internet Engineering Task Force (IETF).
- The IETF is a group of Internet engineers who develop Internet standards on a voluntary basis. ANYONE can participate in the IETF.
- IETF Standards ARE NOT mandatory, any network can choose to implement, or not implement, any of these standards. They are adopted if they are good.
- However, many of these protocols have become truly “standards” in that they are universally used (BGP, TCP/IP, DNS, IPv4 and IPv6).
- The cost of not connecting is too great not to use these standards.



Why the Internet has  
been so successful.



# The Internet Way of Networking (IWN)

We know that the Internet is incredibly successful. The question is: “why?”

- What are the critical elements/properties of the Internet that led to its success and ensure its healthy evolution?

## The Internet Way of Networking – what is it and why it matters

- The Internet owes its success not only to the technology, but to the unique way it operates and evolves. This is what we call the Internet Way of Networking (IWN). It is how independent networks connect to one another, interoperate and, all together, form the global Internet. When the IWN is under threat, so are the opportunities and benefit it offers. In a nutshell, the Internet cannot fulfil its full potential.



# Critical properties and Enablers

## Critical Properties – needed for the Internet *to exist*

- Necessary but not sufficient conditions for the growth, permissionless innovation, interoperability
- The IWN is essential for the Internet healthy evolution

## Enablers – needed for the Internet *to thrive*

- We strive for the Internet that is based on the IWN model: Open, Globally Connected, Secure and Trustworthy (OGST)
- Conditions or facilities that make these goals attainable – the **Enablers**

## CPs and Enablers do not overlap and are not interdependent

- Impact on Critical Properties and Enablers can be considered independently

# Five Critical Properties of IWN – The Internet Model

Technology  
Neutral,  
General-Purpose  
Network



Accessible  
Infrastructure  
with a Common  
Protocol








Open Architecture  
of Interoperable  
and Reusable  
Building Blocks

Common Global  
Identifiers



Decentralized  
Management and  
a Distributed  
Routing System

# Five critical properties and their benefits

	Critical Property	Benefits to the Users
	An Accessible Infrastructure with a Common Protocol	Unrestricted access and common protocols deliver global connectivity and encourage the network to grow. As more and more participants connect, the value of the Internet increases for everyone.
	A layered architecture of interoperable reusable building blocks	Open architecture creates common interoperable services, which deliver fast and permissionless innovation everywhere. The inclusive standardization process and demand-driven adoption ensures that useful changes are adopted, while unnecessary ones disappear.
	Decentralized management and distributed routing	Distributed routing delivers a resilient and adaptable network of autonomous networks, allowing for local optimizations while maintaining worldwide connectivity.
	A Common Global Identifier System	A common identifier set delivers consistent addressability and a coherent view of the entire network, without fragmentation or fractures.
	A General Purpose Network	Generality delivers flexibility. The Internet continuously serves a diverse and constantly evolving community of users and applications. It does not require significant changes to support this dynamic environment.



## An Accessible Infrastructure with a Common Protocol

- You don't need permission from a central authority to connect to the Internet. You find a point nearby, make arrangements to connect, and you're on the Internet.
- Every node has a common, open, network layer protocol available: the Internet Protocol (IP).
- An Internet user trying to use a new application doesn't have to ask questions like "Are they running the same protocol I am?" or "Can I reach their part of the Internet from my part of the Internet?"



## Example: IP Addresses

The fundamental address for Internet infrastructure

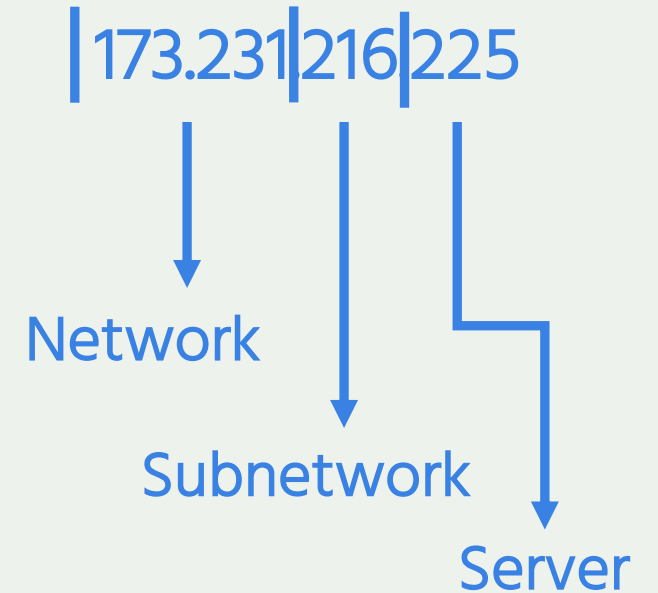
- Every device must have a unique\* IP address
- Every network must have a range (block) of addresses\*

Networks assign IP addresses to the servers connected to their network, not tied to specific servers.

- Makes it easy to connect, improves flexibility and scalability.

Address pools are finite

- IPv4
  - Example: [202.12.29.142](#)
  - 4 billion addresses – mostly exhausted
- IPv6
  - Example: [FE38:DCE3:124C:C1A2:BA03:6735:EF1C:683D](#)
  - 340 billion billion billion billion





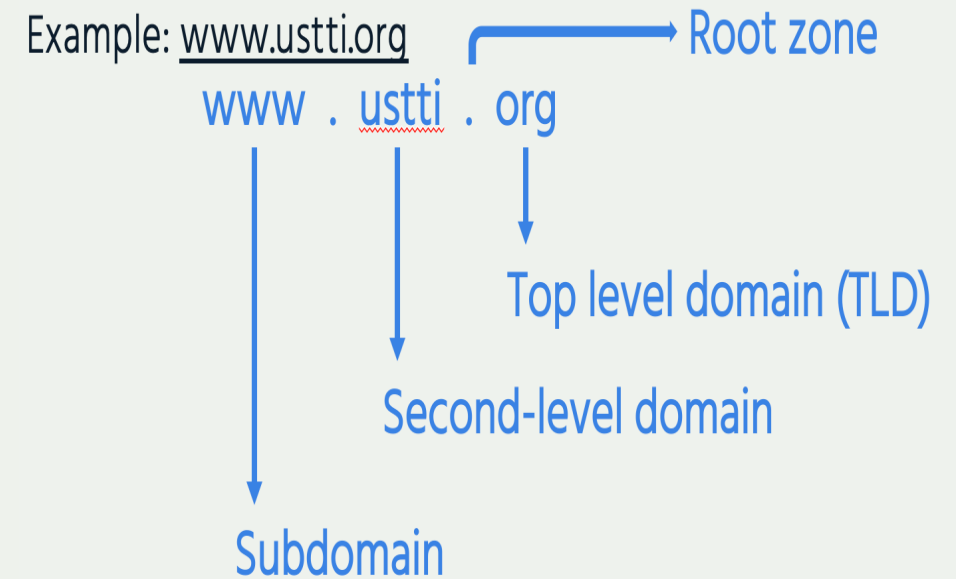
## Open Architecture of Interoperable and Reusable Building Blocks

- Technology building blocks are assembled in a layered fashion, working together to provide services to applications and end-users.
- Each building block delivers a specific function, like supporting different network types, ensuring reliable transport, enabling security, or providing name resolution
- Fast innovation on the Internet is underpinned by an application designer's ability to take advantage of well-defined layered services.



## Example: Domain Name System

- DNS queries enable servers to translate human-friendly names into corresponding computer-friendly IP addresses.
- The “DNS protocol” is the set of rules for network entities to use in queries and responses regarding names in the global, distributed, hierarchical database.
- The content of the server for the domain name system does not matter. The IP Address the server is assigned does not matter. All that matters is that the domain name translate to the right address.





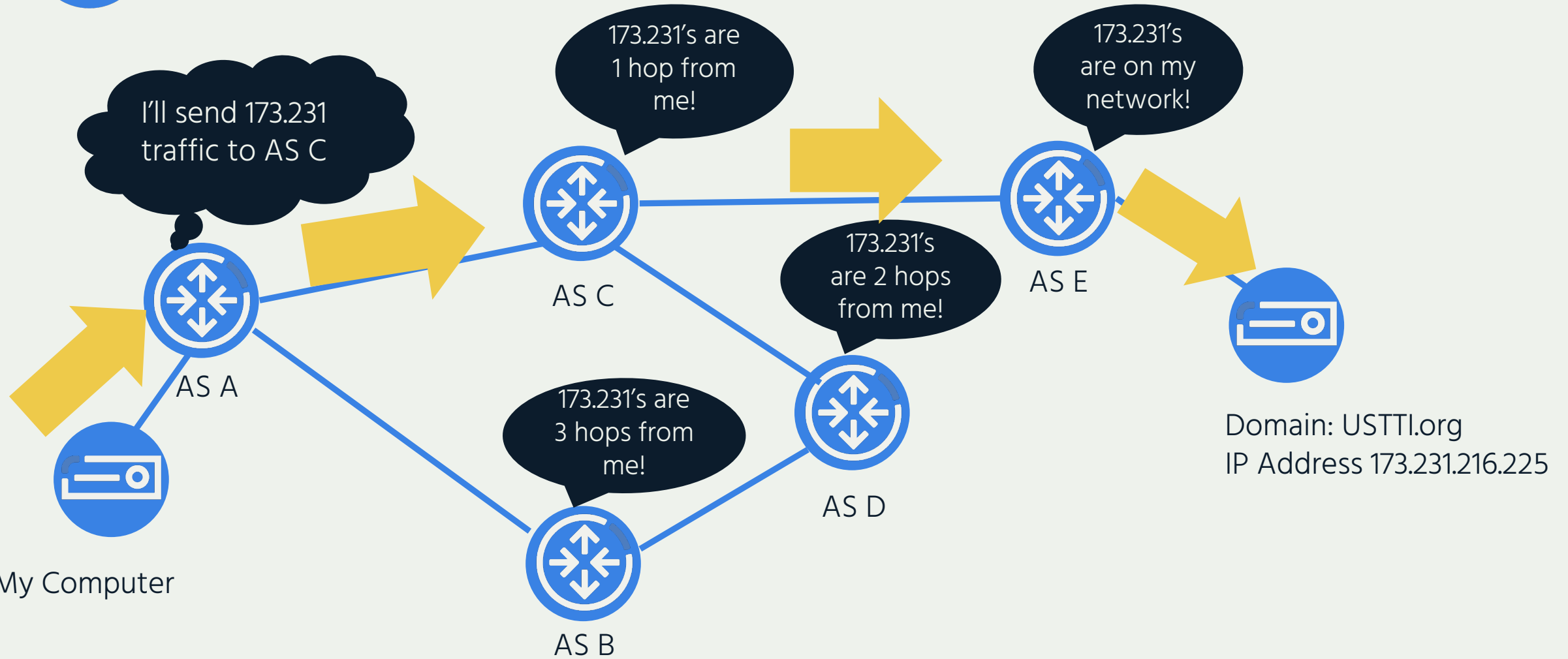
Distributed routing delivers a resilient and adaptable network of autonomous networks, allowing for local optimizations while maintaining worldwide connectivity.

- As a network of networks, the Internet's infrastructure is based on nearly 80,000 independent networks choosing to collaborate and connect together
- Each of these networks runs a common, open, protocol (Border Gateway Protocol, BGP) that allows it to exchange routing information with its neighbors.
- And each of these networks makes independent decisions on how to route traffic to its neighbors, based on its own needs and local requirements.
- The distributed routing system delivers several key benefits: global reach, resilience, and optimized connectivity





# Example: BGP Routing





## A Common Global Identifier System

- There's an essential glue that allows every user to connect to the applications they use: IP addresses.
- Having common global identifiers delivers a key benefit: consistent addressability. The common identifier space, underneath all of the various levels of application, delivers a coherent view of the entire network.
- From any point on the Internet, a tiny packet of information can be passed from computer to computer, each one examining the same few bits — the address — to clearly identify a destination.
- The Domain Name System (DNS) has many uses, but the most common is the creation of a consistent mapping between names and IP addresses



## A General Purpose Network

- The Internet is completely agnostic about the type of content that flows through it, guaranteeing neither quality nor connectivity, yet delivering enough of both to be a base layer for information services, commerce, communications, recreation, and more.
- The benefit of a general-purpose network is its ability to continuously meet the requirements of a diverse, constantly evolving, environment.
- A general-purpose network may not be perfectly optimized for every new application, but it can support most new applications.
- A long-lived general-purpose Internet design lets innovators pursue, without permission, their ideas knowing the network's benefits and drawbacks, enabling fast movement forward while in comparison the network changes are small and gradual.



## Example: Packets

- The Internet Protocol (IP) and Transport Control Protocol (TCP) put data in packets, creates a connection between servers and then sending the data.
- “Packets” are standardized ways to encapsulate data to be sent to the destination.
- You can put any type of data into packets and send them.
- Packets include source IP address and destination IP address.

# Internet Enablers

Enablers of an open, globally-connected, secure and trustworthy Internet.



# Aspirational Goals for a Thriving Internet

Goal	
<b>An Open Internet</b>	The open Internet allows people and organizations to mix and match technologies without permission and with minimal barriers.
<b>A Globally Connected Internet</b>	The globally connected Internet is inclusive. It allows networks and users to interconnect without geographical restrictions.
<b>A Secure Internet</b>	A secure Internet is resistant to attacks on its infrastructure, delivering a robust service to its user community.
<b>A Trustworthy Internet</b>	A trustworthy Internet meets the expectations of its users by offering a resilient and reliable base for applications and services.

# OPEN Means

People and organizations can mix and match technologies

- Without permission
- With minimum barriers

Benefits:

- Spurs innovation
- Promotes the Internet as a force for good.

An Open Internet is an accessible Internet – it is easy to connect to it and use its services



# Supporting an OPEN Internet:

Enabler	Description	Questions
Easy and Unrestricted Access	It is easy to become part of the Internet, for networks and users alike. That means that for users the Internet is affordable and Internet services are accessible, and that network operators can easily become part of the Internet, without unnecessary regulatory or commercial barriers for both groups.	<ul style="list-style-type: none"><li>• Does the proposed change create a barrier to entry, such as costs, administrative overhead, or other difficulties?</li><li>• Is the effect of the change to restrict who can participate, closing down the Internet?</li><li>• Does the proposed change create unnecessary requirements for particular skills or raise costs?</li></ul>



Enabler	Description	Questions
Collaborative Development, Management, and Governance	The Internet's technologies and standards are developed, managed, and governed in an open and collaborative way. This open collaboration extends to the building and operation of the Internet and services built on top of the Internet. The development and maintenance process is based on transparency and consensus, and has as its goal the optimization of infrastructure and services to the benefit of the users of these technologies.	<ul style="list-style-type: none"><li>• Does the proposed change limit collaboration during development, operation, and governance?</li><li>• Is the goal of the proposed policy a restraint on collaboration?</li></ul>

Enabler	Description	Questions
Unrestricted Use and Deployment of Internet Technologies	<p>The Internet's technologies and standards are available for adoption without restriction. This enabler extends to end-points: the technologies used to connect to and use the Internet do not require permission from a third party, OS vendor, or network provider. The Internet's infrastructure is available as a resource to anyone who wishes to use it in a responsible and equitable way. Existing technologies can be mixed in and used to create new products and services that extend the Internet's capabilities.</p>	<ul style="list-style-type: none"><li>• Does the proposed change restrict how the Internet's technologies can be used or deployed?</li><li>• Is the effect of the change to create an unfair or discriminatory limit?</li><li>• Does the proposed change unreasonably limit how end users can manage and control their own devices?</li></ul>

# GLOBALLY CONNECTED Means

Networks and users can connect and communicate without geographical restrictions

Benefits:

- Value of connecting every Internet user together
- Tool for communications, learning, commerce

The Globally Connected Internet is inclusive



# Supporting a GLOBALLY-CONNECTED Internet

Enabler	Description	Questions
Unrestricted Reachability	Internet users have access to all resources and technologies made available on the Internet and are able to make resources available themselves. Once a resource has been made available in some way by its owner, there is no blocking of legitimate use and access to that resource by third parties.	<ul style="list-style-type: none"><li>• Does the proposed change restrict which resources a user can use and access, or restrict the resource the user may contribute to the Internet?</li><li>• Is the effect of the change that a third party can block access to significant parts of the resources of the Internet? the Internet?</li></ul>

Enabler	Description	Questions
Available Capacity	The capacity of the Internet is sufficient to meet user demand. No one expects the capacity of the Internet to be infinite, but there is enough connection capacity---ports, bandwidth, services---to meet the demands of the users.	<ul style="list-style-type: none"> <li>• Does the proposed change act to increase the availability of Internet resources, such as bandwidth or other capacity?</li> <li>• Is the effect of the policy to limit growth and capacity, either directly or indirectly?</li> </ul>

# SECURE Means

- Resistant to attacks on its infrastructure
- Can deliver a robust service to user community
- Does not create insecurities
  - Botnets – phishing scams

## Benefits:

- Internet can be used with minimal risk

Improving information security increases the usefulness of the Internet to all participants.



Enabler	Description	Questions
Data Confidentiality of Information, Services, and Applications	Data confidentiality, usually accomplished with tools such as encryption, allows end users to send sensitive information across the Internet so that eavesdroppers and attackers cannot see the content or know who is communicating. Allowing the transfer of sensitive information helps create a secure Internet. Data confidentiality also extends to data-at-rest in applications. (N.B., “confidentiality” also contributes to privacy, which is part of a trustworthy Internet)	<ul style="list-style-type: none"> <li>• Does the proposed change strengthen or weaken the ability of users to preserve the confidentiality of their information in transit or at rest?</li> <li>• If this change is implemented, do the underlying protocols of the Internet become less confidential?</li> </ul>

# Supporting a SECURE Internet

Enabler	Description	Questions
Integrity of Information, applications, and services	The integrity of data sent over the Internet, and stored in applications, is not compromised. Critical underlying Internet services, such as DNS and the routing system, cannot be manipulated or compromised by malicious actors. Data stored in applications cannot be manipulated or compromised by third parties.	<ul style="list-style-type: none"><li>• Does the proposed change strengthen or weaken the integrity of data, or the ability of users to verify that data are not corrupted? Does the proposed change strengthen or weaken the accuracy and integrity of Internet services, such as DNS?</li></ul>



# TRUSTWORTHY Means

The Internet works how people expect it to

Benefits:

People can rely on the Internet for work/life/etc.

Improving a Trustworthy Internet makes it possible for individuals and organizations to rely on the Internet as a continuing worldwide communications resource.



# Supporting a TRUSTWORTHY Internet

Enabler	Description	Questions
Accountability	Accountability on the Internet gives users the assurance that organizations and institutions they interact with are directly or indirectly acting in a transparent and fair way. In an accountable Internet, entities, services, and information can be identified and the organizations involved will be held responsible for their actions.	<ul style="list-style-type: none"><li>• Does the proposed change create non-transparent authorities or hidden actors?</li><li>• Is the effect of the change to create unaccountable or anonymous authorities who will affect the trust users have in the Internet?</li></ul>

Enabler	Description	Questions
Reliability, Resilience, and Availability	<p>The Internet is reliable when technology and processes are in place that permit the delivery of services as promised. If, for example, an Internet service's availability is unpredictable, then users will observe this as unreliable. This can reduce trust not just in one single service, but in the Internet itself.</p> <p>Resilience is related to reliability: a resilient Internet maintains an acceptable level of service even in the face of errors, malicious behavior, and other challenges to its normal operations.</p>	<ul style="list-style-type: none"><li>• Does the proposed change create unpredictable variations in the Internet's reliability or in the reliability of a service or set of services?</li><li>• Will users be unable to know, from day to day, whether they can use the Internet and its services?</li><li>• Does the proposed change increase or reduce the overall level of the Internet's resilience to malfunction?</li></ul>

Enabler	Description	Questions
Privacy	Privacy on the Internet is the ability of individuals and groups to be able to understand what information about them is being collected and how, and to control how this is used and shared. Privacy often includes anonymity.	<ul style="list-style-type: none"><li>• Does the proposed change reduce or eliminate users' ability to understand how their information is collected, or to control how this information is used and shared?</li><li>• Is the effect to eliminate the possibility for a user to act anonymously?</li></ul>

## Critical Question:

How can we consider the Internet's critical properties and enablers when developing policy?



# An impact assessment for the Internet

Governments are increasingly making decisions that could impact the Internet - and they may not even know it.

By conducting Internet impact assessments, we can prevent harming the Internet and its benefits to us all.



# The Internet Impact Assessment Toolkit

- Helps improve government decisions about the Internet
- Helps policymakers understand the impact – good, neutral or bad – of decisions on the Internet.
- Is free and open for anyone to use.

[internetsociety.org/issues/internet-way-of-networking/internet-impact-assessment-toolkit/](https://internetsociety.org/issues/internet-way-of-networking/internet-impact-assessment-toolkit/)



## How to do an Internet Impact Brief

**This guide will help you write an Internet impact brief.** You can adapt the guidelines to work for you and the specific issue you are considering.

To begin your assessment, follow the steps in the order in which they are listed below. However, you may wish to present your findings in a different order in your final report.

### Goal

The goal of an Internet impact brief is to identify the positive and negative impacts an issue may have on the Internet. Your assessment can generate real impact and be a valuable part of the decision-making process.

✓ **Step 1**  
**Summarize the Issue**

**Document the Relevant Context**

Clearly describe the context and issue to make it easy for the reader to understand how you reach your conclusions.

**Describe the Proposed Change**

Get everyone on the same page by ensuring that the focus and scope of the analysis is clear. For instance, are you analyzing a proposed regulation or law, a change in business model, a new application, or a change in governance?



# Questions?



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