When LLMs Meet ASNs: Rethinking AS-to-Organization Mapping at Internet Scale

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VIRGINIA TECH

AS to Organization

- Central Question:
  - Who actually manages each Autonomous System (AS) on the Internet?
    - These many-to-one and one-to-many patterns make plain why mapping ASNs to organizations is critical for security, measurement, and modeling.
- Existing Approach:
  - Relies on WHOIS data (with PeeringDB augmentation)
  - Clusters ASNs by similar or identical organization names

Observations

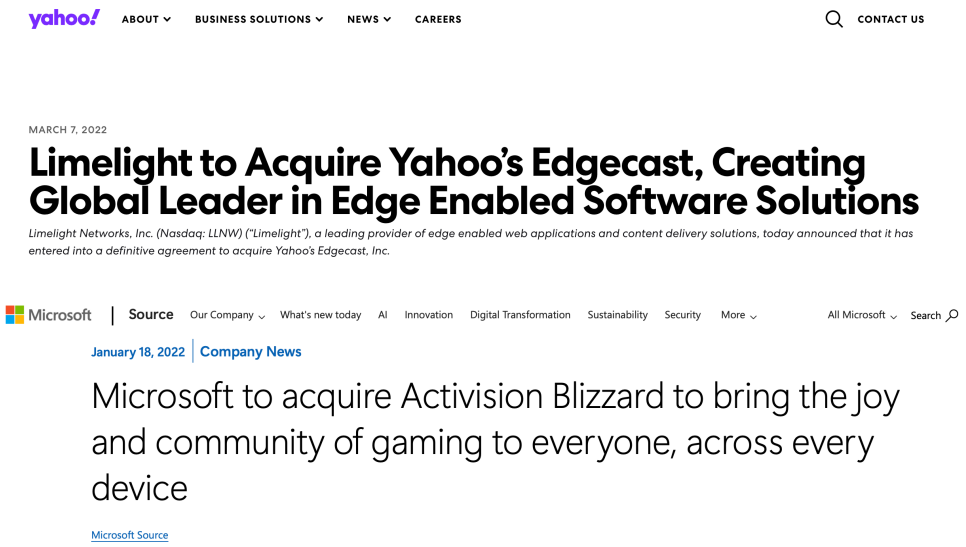
- The Internet provides rich and timely information on organizational cooperation:
  - News, official websites, blogs, Wikipedia…

ZeniMax Media

Article Talk

From Wikipedia, the free encyclopedia

ZeniMax Media Inc. is an American video game holding company based in Rockville, Maryland. The company was founded in 1999 by Christopher Weaver and Robert A. Altman as the parent company for Weaver's video game publisher Bethesda Softworks. The company additionally owns the development studios Bethesda Game Studios (*The Elder Scrolls*, *Fallout*, and *Starfield*), id Software (*Doom*, *Quake*, and *Rage*), Arkane Studios (*Dishonored*, *Prey*, and *Redfall*), MachineGames (*Wolfenstein*), and ZeniMax Online Studios (*The Elder Scrolls Online*). Microsoft acquired ZeniMax Media for $8.1 billion in March 2021 and operates it under the Microsoft Gaming division.



yahoo! ABOUT BUSINESS SOLUTIONS NEWS CAREERS CONTACT US

MARCH 7, 2022

Limelight to Acquire Yahoo's Edgecast, Creating Global Leader in Edge Enabled Software Solutions

Limelight Networks, Inc. (Nasdaq: LLNW) ("Limelight"), a leading provider of edge enabled web applications and content delivery solutions, today announced that it has entered into a definitive agreement to acquire Yahoo's Edgecast, Inc.

Microsoft | Source Our Company What's new today AI Innovation Digital Transformation Sustainability Security More All Microsoft Search

January 18, 2022 | Company News

Microsoft to acquire Activision Blizzard to bring the joy and community of gaming to everyone, across every device

Microsoft Source

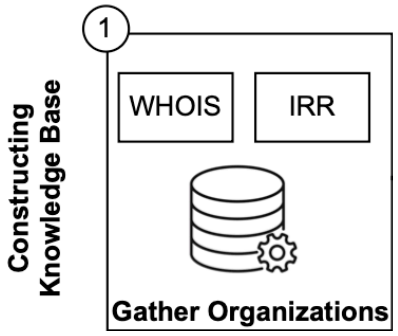
Challenges

- Unstructured Internet text often carries subtle and noisy signals that traditional NLP cannot fully capture.
- LLMs help to discover the relation from text, but they face several limitations:
  - **Hallucinations**: Models may fabricate or misclassify relationships.
  - **Needle-in-a-Haystack**: Subtle organizational ties are easily lost in massive corpora.
  - **Scalability**: With 90,000 organizations, a brute-force pairwise check would mean ~8.1B queries.

Solutions

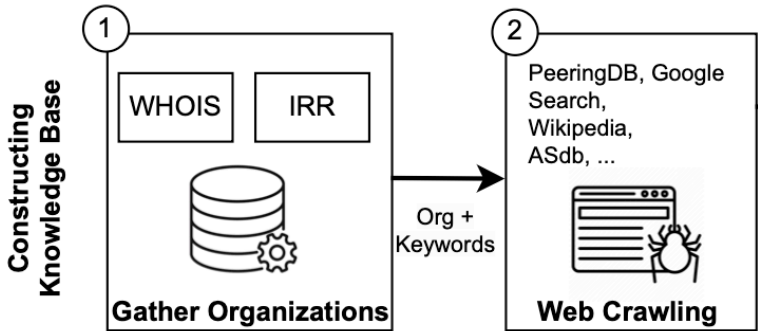
- Solutions for aforementioned limitations.
  - **Hallucinations**: Mitigated by Retrieval-Augmented Generation (RAG) and careful prompt engineering
  - **Needle-in-a-Haystack**: Mitigated by NER- and embedding-based filtering
  - **Scalability**: Traditional clustering methods using LLM output

Our Proposed Solution
ASINT Pipeline (1)



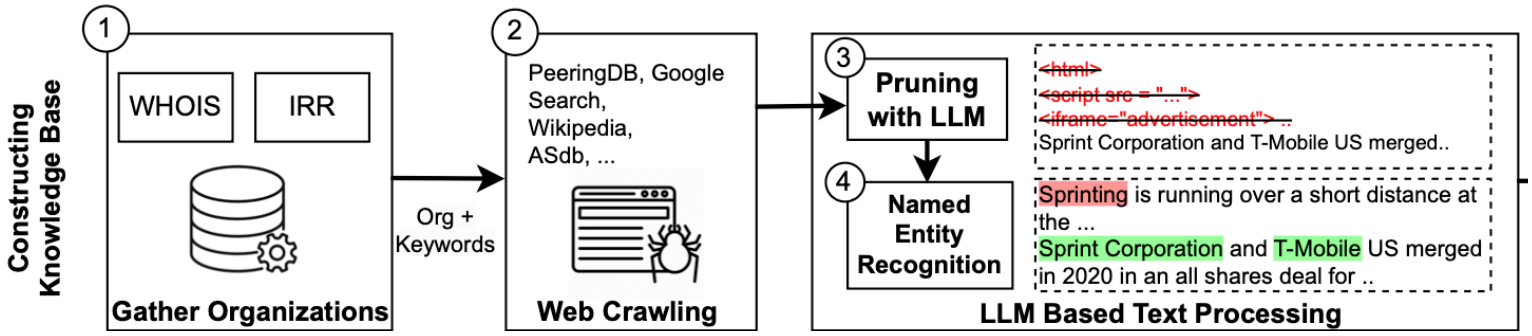
1. Gather the list of “potential” organizations from WHOIS, IRR, and PeeringDB

ASINT Pipeline (2)



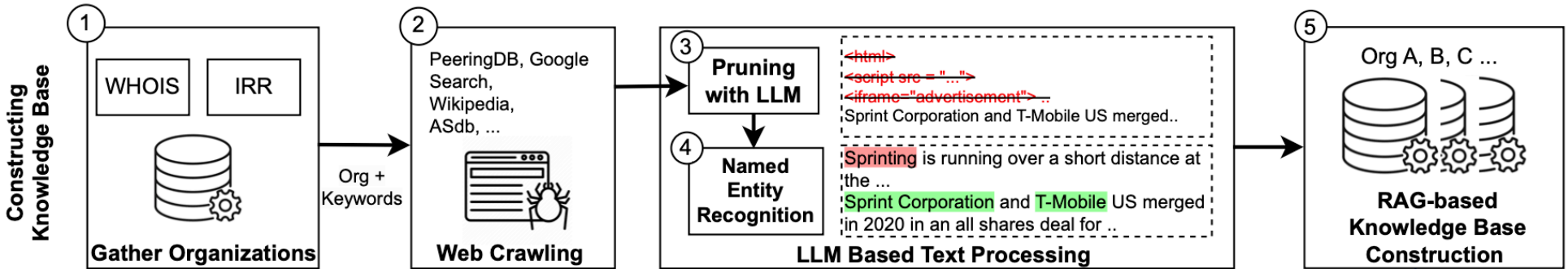
2. Construct queries for each organization using keywords such as “acquisition,” “merged,” “alias,” and related terms

ASINT Pipeline (3 & 4)



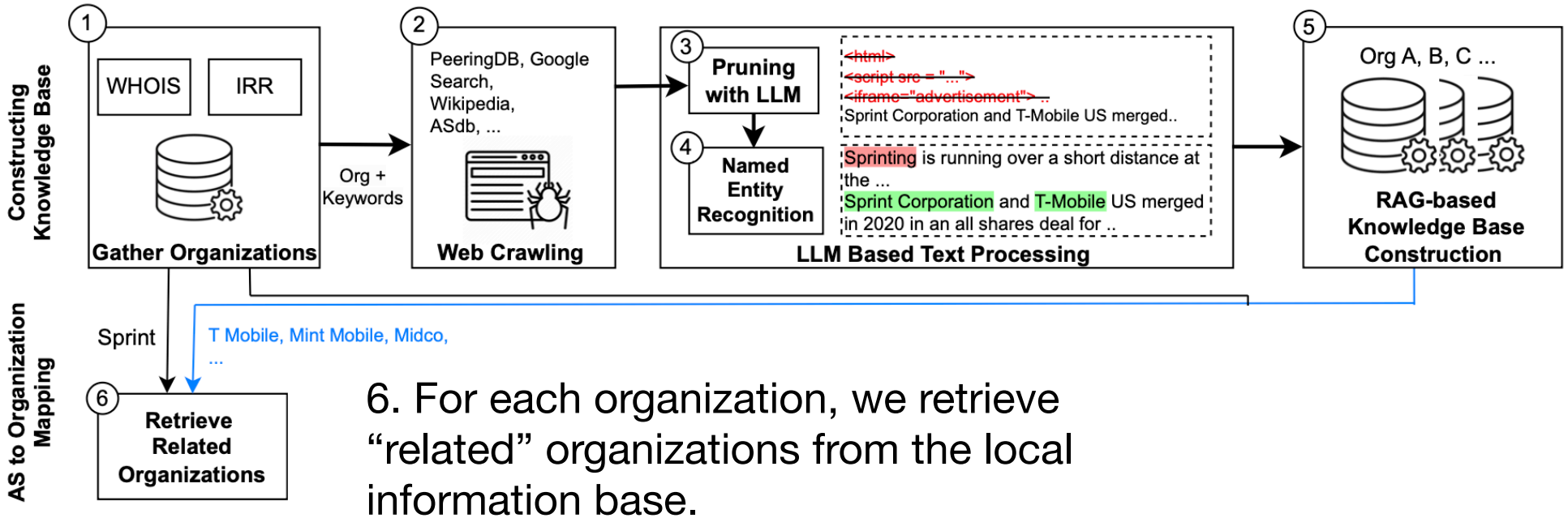
3 & 4. Apply Named Entity Recognition (NER) to filter out unrelated content (e.g., HTML tags, ads, JavaScript, etc.)

ASINT Pipeline (5)



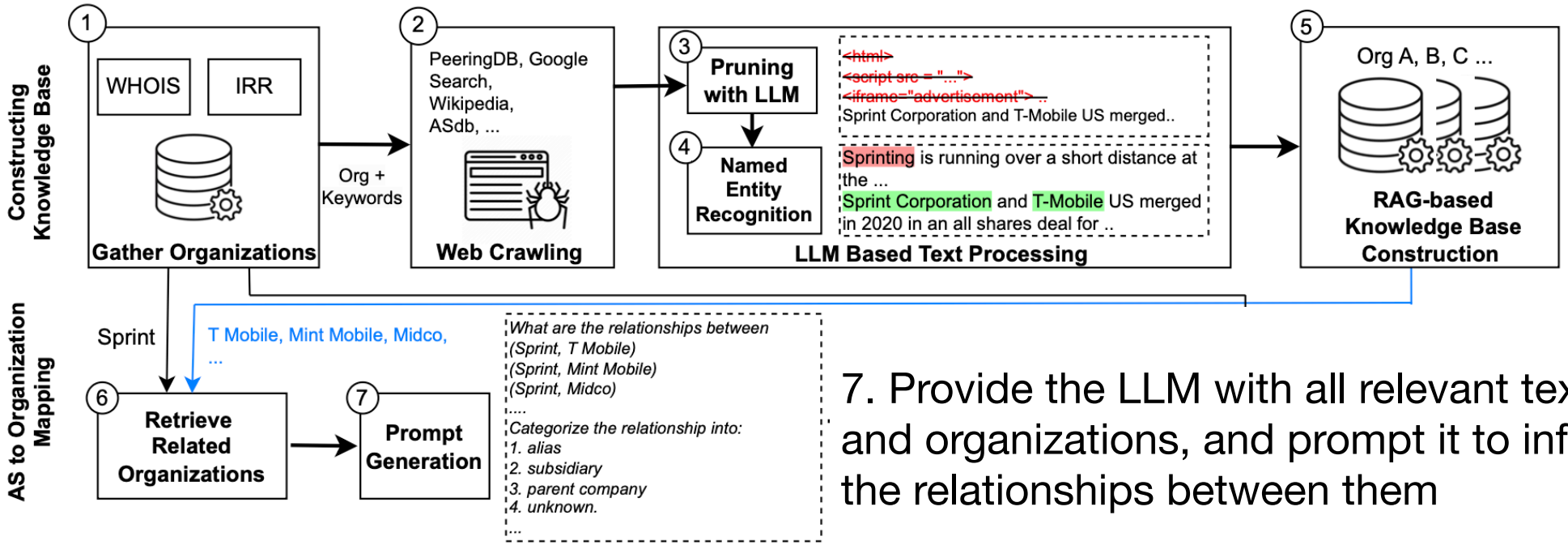
5. Construct a “local information base” for later Retrieval-Augmented Generation (RAG) by pulling in real-time corporate disclosures

ASINT Pipeline (6)



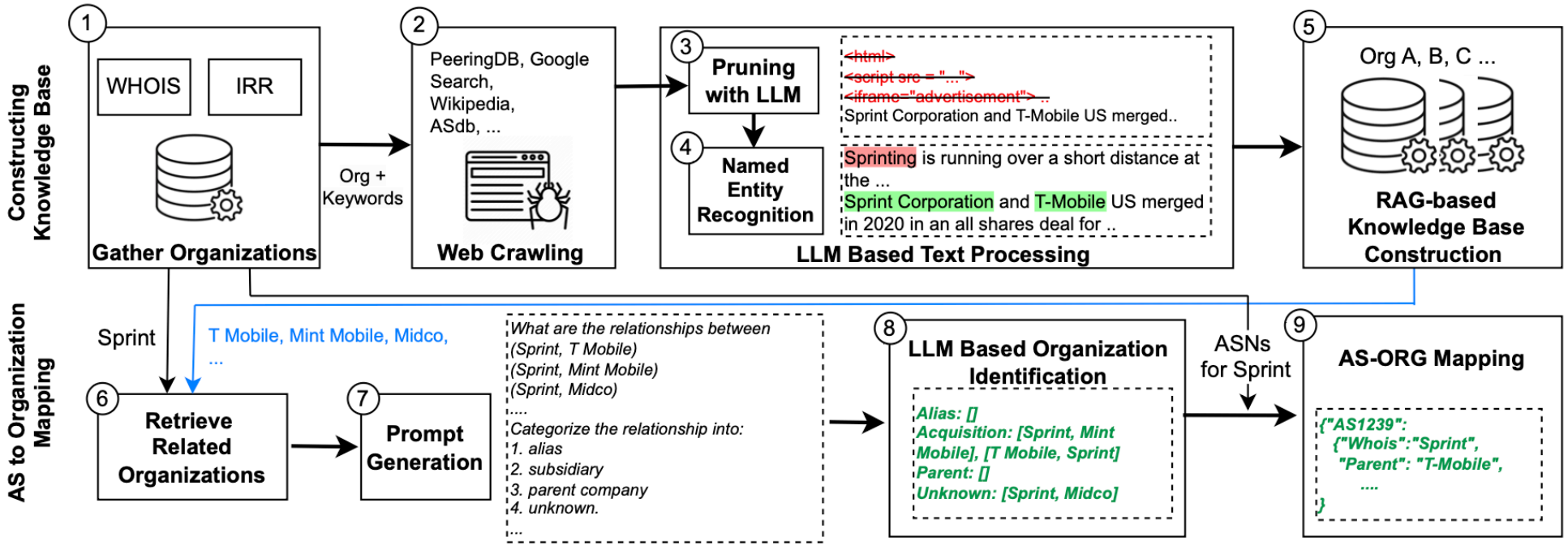
6. For each organization, we retrieve “related” organizations from the local information base.

ASINT Pipeline (7)



7. Provide the LLM with all relevant text and organizations, and prompt it to infer the relationships between them

ASINT Pipeline (8)



8 & 9. Identify the organizations and produce the final results

From AS Records to RAG-Ready Database

- Data Sources and Scale
  - WHOIS: 11,470 ASNs and 3,503,706 organization records
    - Only 65,842 records matched to at least one ASN
  - PeeringDB: 30,058 ASes and 28,329 organizations
- Query & Collection Process
  - Constructed queries for 88,101 distinct organizations
  - Fetched 873K webpages (~20M text chunks)
- We group related organizations under the same administrative entity — this grouping is referred to as an *organization family*.

ASINT Website
https://asint.netsecurelab.org

AS-to-Organization Mapping Tool

ASINT maps Autonomous System Numbers (ASNs) to the real-world organizations that own or operate them. It goes beyond WHOIS or PeeringDB data by leveraging registry data, web crawling, and large language models to uncover relationships like rebranding, acquisitions, and subsidiaries.

Search for ASN or Organization

Mode: **ASN** ORG

ASN Search, which returns the ASN and its related ASNs.

Enter an ASN number to look up related organization family.

8523 Search

Alias ID	RIR	ASN	AS Name	Org Name	Parent	Children	Feedback
5	RIPE	8891	UNSPECIFIED	Orange S.A.	-	-	👍 👎
5	RIPE	12807	OAB	Orange Business Services SA	-	-	👍 👎
5	RIPE	6853	ORANGE-BUSINESS-SERVICES-SOUTHEUR	ORANGE BUSINESS SERVICES U.S. Inc.	-	-	👍 👎

ASINT Website
https://asint.netsecurelab.org

Enter an organization name (partial or full) to search.

microsoft Search

ORG Search, which returns the ASN (that has org name) and its related ASNs.

Organization Family ID: 14

Alias ID	RIR	ASN	AS Name	Org Name	Parent	Children	Feedback
5885	RIPE	202167	ZeniMax-Germany	ZeniMax Germany GmbH	2804	-	👍 👎
2804	ARIN	18733	ZENIMAXMEDIA	ZeniMax Media Incorporated	5878	5886 5885	👍 👎
2804	ARIN	54947	ZENIMAXONLINE	ZeniMax	5878	5886 5885	👍 👎
5878	ARIN	3598	MICROSOFT-CORP-AS	Microsoft Corporation	-	2804	👍 👎
...							
5878	ARIN	400582	MICROSOFT-AZURE-DEDICATED	Microsoft Corporation	-	2804	👍 👎
5878	ARIN	400884	AONSERVICE	Microsoft Corporation	-	2804	👍 👎
5886	ARIN	10793	IDSOFT	ID Software	2804	-	👍 👎

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Enter an organization name (partial or full) to search.

microsoft Search

ZeniMax Germany is a subsidiary of ZeniMax Media, the parent company headquartered …

Organization Family ID: 14

Alias ID	RIR	ASN	AS Name	Org Name	Parent	Children	Feedback
5885	RIPE	202167	ZeniMax-Germany	ZeniMax Germany GmbH	2804	-	👍 👎
2804	ARIN	18733	ZENIMAXMEDIA	ZeniMax Media Incorporated	5878	5886 5885	👍 👎
2804	ARIN	54947	ZENIMAXONLINE	ZeniMax	5878	5886 5885	👍 👎
5878	ARIN	3598	MICROSOFT-CORP-AS	Microsoft Corporation	-	2804	👍 👎
…							
5878	ARIN	400582	MICROSOFT-AZURE-DEDICATED	Microsoft Corporation		2804	👍 👎
5878	ARIN	400884	AONSERVICE	Microsoft Corporation		2804	👍 👎
5886	ARIN	10793	IDSOFT	ID Software	2804	-	👍 👎

Id Software was acquired by Zenimax Media (On June 24, 2009)

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Enter an organization name (partial or full) to search.

microsoft Search

Organization Family ID: 14

Alias ID	RIR	ASN	AS Name				
5885	RIPE	202167	ZeniMax-Germany				
2804	ARIN	18733	ZENIMAXMEDIA	ZeniMax Media Incorporated	5878	5886 5885	
2804	ARIN	54947	ZENIMAXONLINE	ZeniMax	5878	5886 5885	
5878	ARIN	3598	MICROSOFT-CORP-AS	Microsoft Corporation	-	2804	

...

5878	ARIN	400582	MICROSOFT-AZURE-DEDICATED	Microsoft Corporation	-	2804	
5878	ARIN	400884	AONSERVICE	Microsoft Corporation	-	2804	
5886	ARIN	10793	IDSOFT	ID Software	2804	-	

Microsoft finalizes acquisition of ZeniMax Media

Last September, Microsoft made an announcement that changed the landscape of the gaming industry forever. In acquiring ZeniMax Media, the parent company of Bethesda Softworks and its eight incredible studios, Microsoft planned to bring the creators of critically acclaimed and best-selling gaming franchises (including The Elder Scrolls, Fallout and many others) into the Xbox family. Today is an exciting day for gamers around the world as we officially finalize the acquisition.

Bethesda brings an impressive portfolio of games, technology, talent and a track record of blockbuster commercial success. We are excited to welcome eight incredibly talented development studios and their passionate player communities to Team Xbox, and look forward to bringing Bethesda's future games into Xbox Game Pass the same day they launch on Xbox, PC and Android through the cloud.

To learn more about how Bethesda and Xbox are coming together, head over to Xbox Wire and Bethesda.

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Search for ASN or Organization

Mode: ASN **ORG**

ORG Search, which returns the ASN (that has org name) and its related ASNs.

Enter an organization name (partial or full) to search.

verizon Search

Organization Family ID: 1022

Alias ID	RIR	ASN	AS Name	Org Name	Parent	Children	Feedback
205	RIPE	56583	BJN-AS	Blue Jeans Network, LLC	-	-	👍 👎
205	RIPE	200137	BJN-AS2	Blue Jeans Network, LLC	-	-	👍 👎
205	APNIC	132402	BJN-AP	Blue Jeans Network	-	-	👍 👎
205	APNIC	133095	BJN-AU	Blue Jeans Network	-	-	👍 👎

ASINT Website
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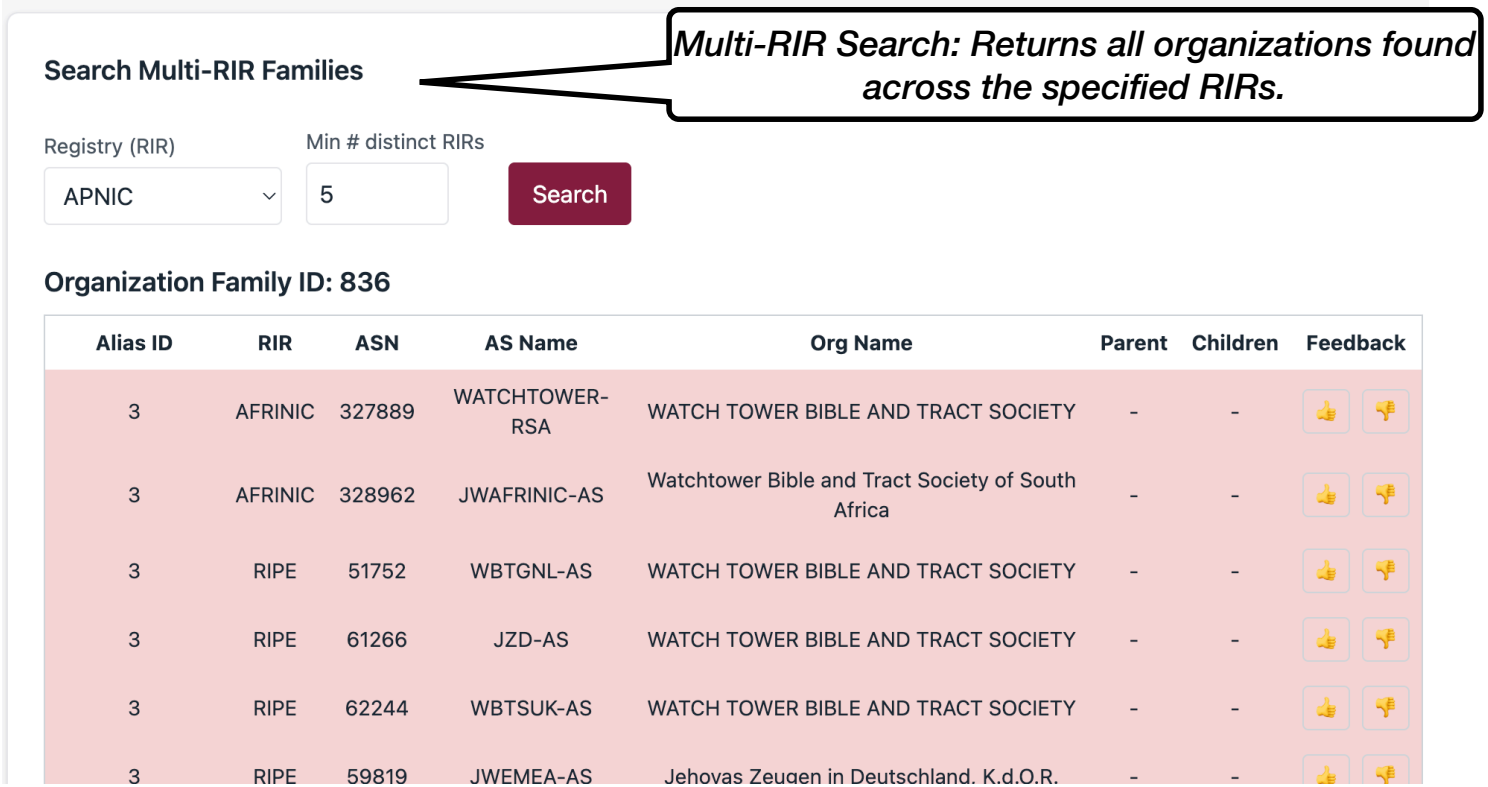

Project Status

- We publish new datasets every month.
- Self-hosted LLMs for sustainability and cost control.
- Pipeline or model upgrades roll into the next snapshot; a changelog ships with each release.
- Roadmap: cross-snapshot diffs and group-change tracking
- Need bulk dataset access (dump)? Email us.

Case-Study (1): Multi-RIR companies

Alias ID	RIR	ASN	AS Name	Org Name
6	AFRINIC	328312	Deloitte-AS	Deloitte & Touche South Africa
6	AFRINIC	328968	Deloitte-AS	Deloitte & Touche South Africa
6	RIPE	15939	DELOITTEAT-AS	Deloitte Services Wirtschaftsprufungs GmbH
6	RIPE	42536	Deloitte-UK	Deloitte LLP
6	RIPE	42633	DeloitteToucheTohmatsu-Global	Deloitte Touche Tohmatsu Services, LLC
6	RIPE	43187	DELOITTE-HU-AS	Deloitte Advisory and Management Consulting Ltd.
6	RIPE	48342	Deloitte-And-Touche-Irl	Deloitte & Touche
6	RIPE	47661	Deloitte-DE	Deloitte GmbH Wirtschaftspruefungsgesellschaft
6	ARIN	26342	DTTS-ASN	Deloitte Touche Tohmatsu Services, Inc.
6	JPIRR	131077	TOHMATSU-NET	Deloitte Tohmatsu Group LLC
6	LACNIC	272103	N/A	DELOITTE & TOUCHE LTDA

Case-Study (2): Orange

Alias ID	RIR	ASN	AS Name	Org Name
5	RIPE	60940	CLOUDWATT	Orange Business Services SA
5	RIPE	199749	PRISME	Orange Business Services SA
5	RIPE	198528	OGN-RU	ORANGE BUSINESS COMMUNICATIONS TECHNOLOGY LIMITED
5	APNIC	4861	GLOBAL-IP-KOREA-AS-AP	Equant Inc
5	ARIN	7758	GLOBAL-ONE-NMC	Global One
5	ARIN	10280	DIALIP-E-SW	GLOBAL ONE
5	ARIN	10281	DIALIP-E-NE	GLOBAL ONE
5	LACNIC	6505		EQUANT BRASIL LTDA
5	RIPE	28708	ORANGEFR-PORTAL-AS	Orange S.A.
5	RIPE	13879	SITA-EQUANT-MPLSNET	ORANGE BUSINESS SERVICES U.S. Inc.
			...	

Case-Study (2): Orange

"Orange Business was founded on 1 June 2006,through a rebranding and consolidation of the existing France Telecom businesses of Equant and Wanadoo"

Alias ID	RIR	A		Org Name
5	RIPE	6		ange Business Services SA
5	RIPE	19		ange Business Services SA
5	RIPE	198528	OGN-RU	ORANGE BU INESS COMMUNICATIONS TECHNOLOGY LIMITED
5	APNIC	4861	GLOBAL-IP-KOREA-AS-AP	Equant Inc
5	ARIN	7758	GLOBAL-ONE-NMC	Global One
5	ARIN	10280	DIALIP-E-SW	GLOBAL ONE
5	ARIN	10281	DIALIP-E-NE	GLOBAL ONE
5	LACNIC	6505		EQUANT BRASIL LTDA
5	RIPE	28708	ORANGEFR-PORTAL-AS	Orange S.A.
5	RIPE	13879	SITA-EQUANT-MPLSNET	ORANGE BUSINESS SERVICES U.S. Inc.
			...	

Case-Study (2): Orange

Alias ID	RIR	ASN	AS Name	Org Name
5	R			Orange Business Services SA
5	R			Orange Business Services SA
5	R			RANGE BUSINESS COMMUNICATIONS TECHNOLOGY LIMITED
5	APNIC	4861	GLOBAL-IP-KOREA-AS-AP	Equant Inc
5	ARIN	7758	GLOBAL-ONE-NMC	Global One
5	ARIN	10280	DIALIP-E-SW	GLOBAL ONE
5	ARIN	10281	DIALIP-E-NE	GLOBAL ONE
5	LACNIC	6505		EQUANT BRASIL LTDA
5	RIPE	28708	ORANGEFR-PORTAL-AS	Orange S.A.
5	RIPE	13879	SITA-EQUANT-MPLSNET	ORANGE BUSINESS SERVICES U.S. Inc.
			…	

"PARIS-Equant and France Telecom's Global One announced they will merge, forming a company with … of up to $3 billion."

Use Case
(1) Organization Cone Size and Ranking

- Accurate estimates of an ISP's "customer cone" are central to many topology and ranking analyses.
- Among the 89,072 organizations in CAIDA's AS Rank dataset, we observe that 11,760 organizations see a larger cone size.
  - Charter's cone size nearly doubles (from 962 to 1,819 ASes) after identifying 237 ASes under its control, raising its rank from 64 to 32.

Org Name	New Rank	New Cone Size
TATA	6 (▲ 2)	21,782 (+2,447)
Orange	12 (-)	9,958 (+1,927)
Charter	32 (▲ 32)	2,781 (+1,819)
Vodafone	14 (-)	8,479 (+1,708)
Comcast	23 (▲ 12)	3,862 (+1,513)
Liberty Global	21 (▲ 9)	4,030 (+1,361)
GlobeNet Cabos	19 (▲ 8)	4,156 (+1,340)
Telstra	13 (-)	8,930 (+1,282)
Deutsche Telekom	16 (▲ 3)	5,198 (+1,191)
Stowarzyszenie	44 (▲ 51)	1,652 (+1,014)

Use Case
(2) Hijack Detection

- BGP hijacking remains a serious threat to Internet security. Existing hijack detection platforms (e.g., Cloudflare Radar) often rely on AS2Org to filter out potential false positives: if two ASes belong to the same organization, an overlapping prefix announcement might be legitimate rather than malicious.

- Used 17,282 hijack alerts from January 2023 to July 2024; 8.5% of Radar's alarm involve AS pairs owned by the same organization (i.e., false positive)

  - We validated 100 randomly selected cases by emailing each allegedly "victimized" operator's publicly listed contact. Of the 32 who responded, all of them confirmed the event was an internal reannouncement rather than a hijack.

Use Case
(3) ROA Misconfiguration

- Sometimes BGP origin does not match with ROA origin.
- RPKI helps, but multi-AS orgs can still misconfigure origin-AS if an organization incorrectly assigns multiple ASNs under its umbrella; Prior work [8] used CAIDA's CA2O to identify RPKI-invalid prefixes announced by the same organization's ASes.
  - Are all RPKI-invalid BGP announcements hijack? No!
- Replication: Jan 2023 to Jul 2024 using RouteViews tables and ROAs from all 5 RIRs; 42,654 RPKI-invalid prefixes.
  - Baseline with CAIDA CA2O: 4,436 intra-org misconfigs.
  - With ASINT: +1,219 more intra-org cases, a 27.5 percent lift; these were missed because the ASNs were not unified.

Limitation: false positives from name look-alikes

- ASINT grouped *Raiffeisen Rechenzentrum GmbH* and *Raiffeisen Informatik GmbH & Co KG* together, which is wrong.
  - In short, one org's former name is the other org's current name. "The confusion arises because Raiffeisen Informatik was formerly known as Raiffeisen Rechenzentrum (RRZ) until its 2004 rebranding. Conversely, the other company, Raiffeisen Rechenzentrum GmbH, is an independent IT provider near Graz, Austria, that is a subsidiary of PROGRAMMIERFABRIK GmbH and has its own distinct corporate identity."
- ASINT thinks PT Comtronics Systems and IPLUS LLC are alias, which is wrong.
  - PT Comtronics Systems operates under the name COMNET, and IPLUS LLC operates under the same name COMNET. But they are different. Same brand in different region.

ASINT Website
(1) We need your feedback

- We acknowledge that our results may contain errors. If you can provide feedback (e.g., references like URL of news), we will incorporate it to improve and revise our results.

You can either vote on the result, or leave comment!

Organization Family ID: 7959

Alias ID	RIR	ASN	AS Name	Org Name	Parent	Children	Feedback
9378	ARIN	1312	VA-TECH-AS	Virginia Polytechnic Institute and State Univ.	-	-	👍 1 👎 0 This is good Add comment
9378	ARIN	26499	VATECH-DCMETRO	Virginia Polytechnic Institute and State Univ.	-	-	👍 👎
9378	ARIN	40220	MARIA	Virginia Polytechnic Institute and State Univ.	-	-	👍 👎

Email me: tijay@vt.edu
(2) We need your use cases and feedback!

- How do you use AS-to-ORG mapping?
  - For example, in hijacking detection or RPKI misconfiguration handling.
  - Currently, the hijacking detection system whitelists a prefix if it is announced from an RPKI-invalid origin but still belongs to the same organization.
  - It is completely fine if you leave a feedback “I don’t use AS-to-ORG mapping”
- What AS to ORG mapping datasets do you use?
- What are the challenges or required features that would improve your network management?

Questions?

- The paper is available here: https://arxiv.org/abs/2508.02571