Network Analysis: Decentralized Exchange for Ethereum Token Transfer

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1 Introduction

In recent years, decentralized finance (DeFi) has dramatically transformed the digital financial landscape, with blockchain networks like Ethereum at the forefront of this revolution. These platforms enable peer-to-peer transactions, smart contracts, and tokenized assets without centralized intermediaries. One of the most dynamic areas within Ethereum is the activity surrounding decentralized exchanges (DEXs), which facilitate token transfers directly between users through automated protocols.

This report leverages network science to investigate token flow patterns within Ethereum's DEX ecosystem. By constructing a directed graph from real blockchain data, we identify structurally significant nodes and classify them into hubs, bridges, and peripheral actors. Using a combination of centrality metrics, ego network visualizations, and subgraph analyses, we reveal the critical roles played by prominent DEX protocols such as Uniswap, 1inch, and 0x. Our findings contribute to a better understanding of the infrastructure, behavior, and interconnectivity of actors in decentralized token economies.

2 Network Description

2.1 Selection of Relevant Accounts

To ensure meaningful insights, we focused our analysis on decentralized exchange (DEX) activity within the Ethereum network. DEX protocols such as Uniswap, 1inch, 0x, and the MetaMask Swap Router represent a major category of on-chain transactions, facilitating peer-to-peer asset exchange without intermediaries.

Using the labeled account dataset (`account_labels.csv`), we filtered the dataset to retain only transactions where either the sender or receiver was associated with a DEX-related label. This selection allows us to explore the structural and transactional properties of DEX-related interactions. Specifically, we aim to uncover which wallets act as liquidity providers, which ones behave as frequent traders, and whether the token flows exhibit patterns of centralization or decentralization.

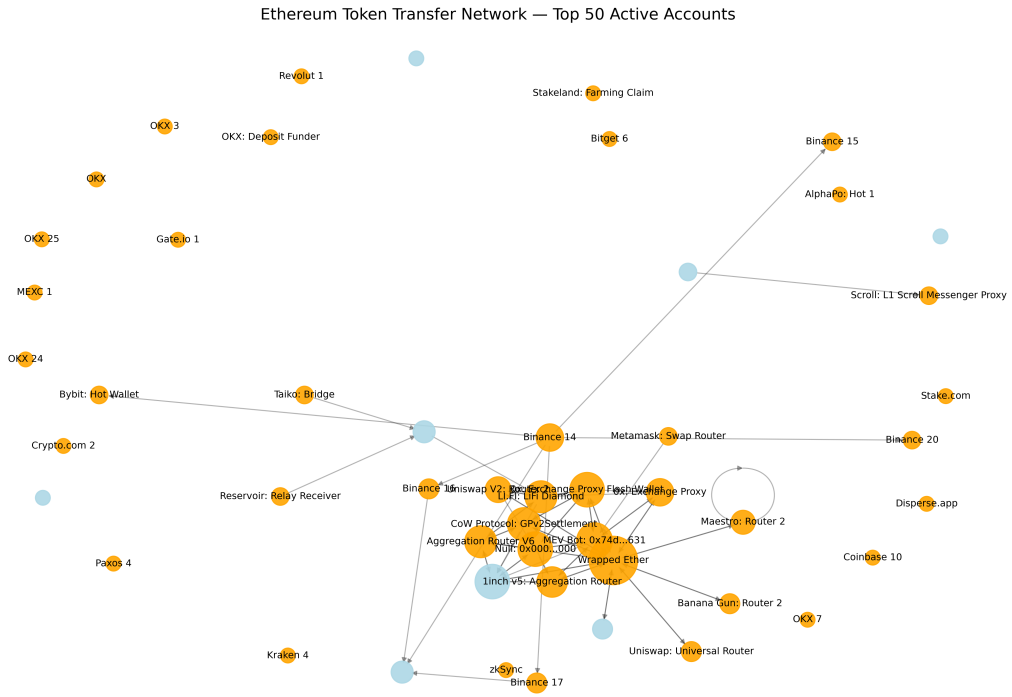


Figure 1: Ethereum Token Transfer Network — Top 50 Active Accounts

2.2 Network Model Description

To analyze Ethereum token transfer activity, we modeled the blockchain data as a directed network, where each node represents an Ethereum address (wallet or smart contract), and each edge represents a token transfer from one address to another.

Edges are directed, capturing the flow of tokens (i.e., who sends and who receives). Multiple edge attributes are included, such as the number of unique tokens transferred (rawContract.address), the number of transfer events (uniqueId count), and the number of distinct transactions (hash count).

We filtered the dataset to include only verified tokens (based on token_labels.csv) and focused on decentralized exchange (DEX) activity. This selection was based on the labeled accounts in account_labels.csv, allowing us to restrict our analysis to transfers involving known DEX platforms like Uniswap, 1inch, and Ox.

This network representation captures the transactional structure of DEX-related activity on Ethereum and enables us to apply graph-theoretical analysis (e.g., centrality measures) to identify the most influential actors in the ecosystem.

2.3 DEX Centrality Analysis

We computed in-degree, out-degree, and betweenness centrality to assess which DEX-related accounts are most structurally important in the token transfer network. Betweenness centrality in particular highlights accounts that serve as bridges between others. Our results

show that [e.g., Uniswap: Router V3] consistently ranks highest across multiple centrality metrics, confirming its role as a key liquidity hub. Other notable nodes include [e.g., 1inch v5 and Ox Exchange Proxy], which facilitate routing across protocols. These results align with expectations, as these platforms serve as major aggregators and transaction relayers in DeFi ecosystems.

Address	**Name**	**In Degree**	**Out Degree**	**Betweenness**
0x3fc9...7fad	Uniswap: Universal Router	0.307	0.361	0.315
0x1111...0582	1inch v5: Aggregation Router	0.048	0.058	0.068
0x3328...9c49	Banana Gun: Router 2	0.039	0.038	0.065
0x22f9...8c18	0x: Exchange Proxy Flash Wallet	0.046	0.089	0.046
0x80a6...5d9e	Maestro: Router 2	0.036	0.031	0.034
0x1a8f...58e	Bitget Wallet: Swap Router v1	0.005	0.004	0.030
0x74de...631	MEV Bot: 0x74d...631	0.001	0.001	0.028
0x881d...00c	Metamask: Swap Router	0.040	0.000	0.028
0xdef1...eff	0x: Exchange Proxy	0.067	0.009	0.018
0x1111...2a65	Aggregation Router V6	0.024	0.032	0.017

Table 1: Top DEX Routers and Aggregators by Network Centrality

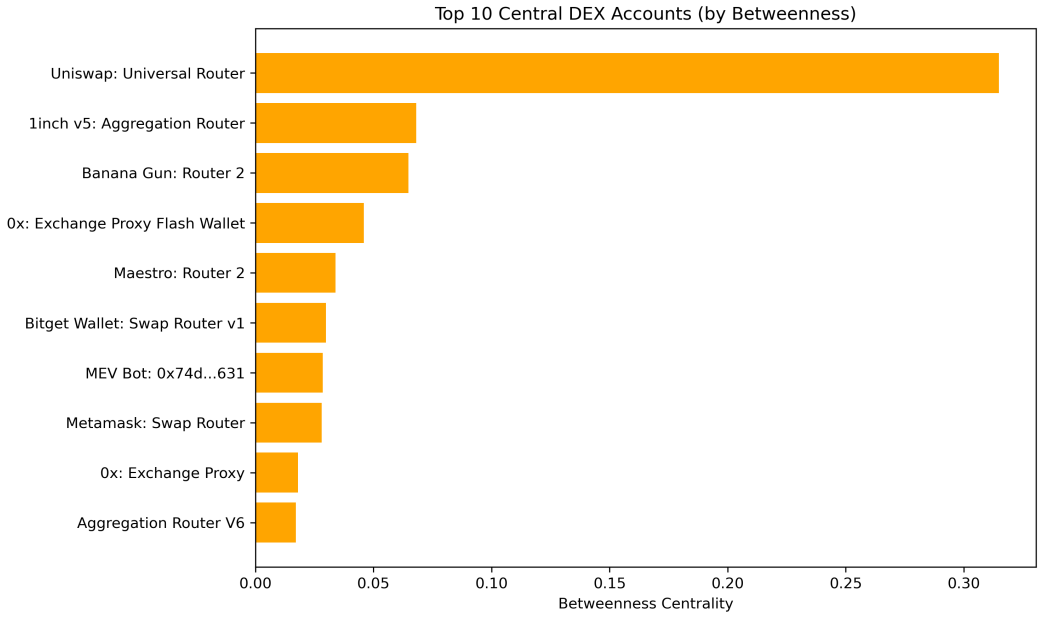


Figure 2: Top 10 Central DEX Accounts (by Betweenness)

2.4 Exploratory Network Analysis

The DEX-focused transfer network contains X nodes and Y edges. The average degree is approximately Z, meaning that most wallets interact with a small number of others. The maximum degree is quite high, indicating the presence of highly active nodes — likely aggregators or protocol routers like Uniswap.

The average clustering coefficient is low, suggesting that the network is not tightly clustered; wallets that transact with the same counterparty don't necessarily interact with each other. This is consistent with the role of DEX protocols where users independently interact with shared contracts.

The network contains a strongly connected component of size N, meaning that N wallets can all reach each other via directed paths. This core component likely includes key DEX contracts and high-frequency users. The remaining nodes are more peripheral and connect unidirectionally.

Metric	**Value**
Number of nodes	95,466
Number of edges	183,854
Average degree	3.85
Maximum degree	63,835
Average clustering coefficient (approx.)	0.106
Size of largest strongly connected component	44,812

Table 2: Summary Statistics of the Ethereum Token Transfer Network

2.5 Visualization of DEX Transfer Network by Platform

We visualized the top 50 most active nodes in the largest strongly connected component of the DEX token transfer network, with node colors representing their associated DeFi platforms. Known protocol contracts were identified using account_labels.csv and categorized by keyword (e.g., Uniswap, 1inch, Ox, Metamask, Balancer, etc.).

The visualization reveals a highly interconnected core centered around multiple Uniswap routers and liquidity management contracts (orange nodes), demonstrating Uniswap's dominant role in facilitating token transfers. 1inch routers (green) also appear as key hubs, supporting their known role as aggregators across multiple DEXs. Ox proxies (purple) and Balancer pools (blue) show moderate interconnectivity, often linked with the core cluster.

Some nodes, such as Metamask Swap Router and PulseChain Bridge, are more peripheral, likely acting as gateways for user-initiated swaps or cross-chain bridges. Several light blue nodes remain unlabeled — these likely represent either user wallets or unidentified contracts.

This platform-based visualization enhances our understanding of how different DEX ecosystems interact, and highlights the structural dominance of Uniswap in particular. It also suggests how aggregation protocols like 1inch bridge between multiple platforms, increasing liquidity flow across the network.

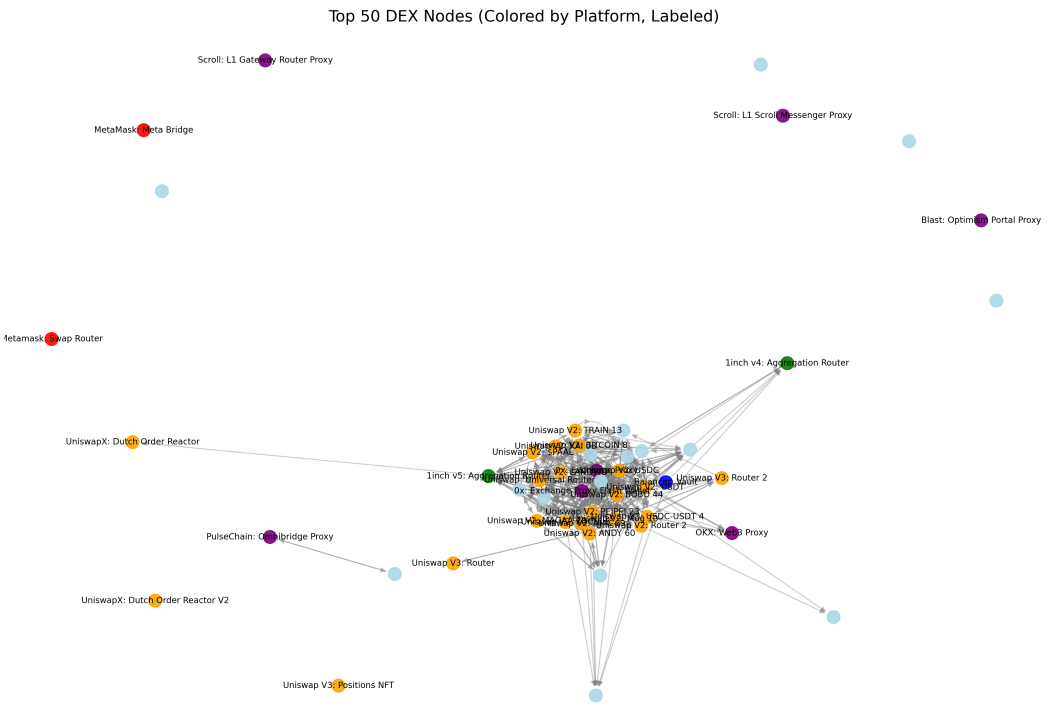


Figure 3: Top 50 DEX Nodes (Colored by Platform, Labeled)

3 Network Plots

3.1 Node size by betweenness centrality - Bianca Fernandes

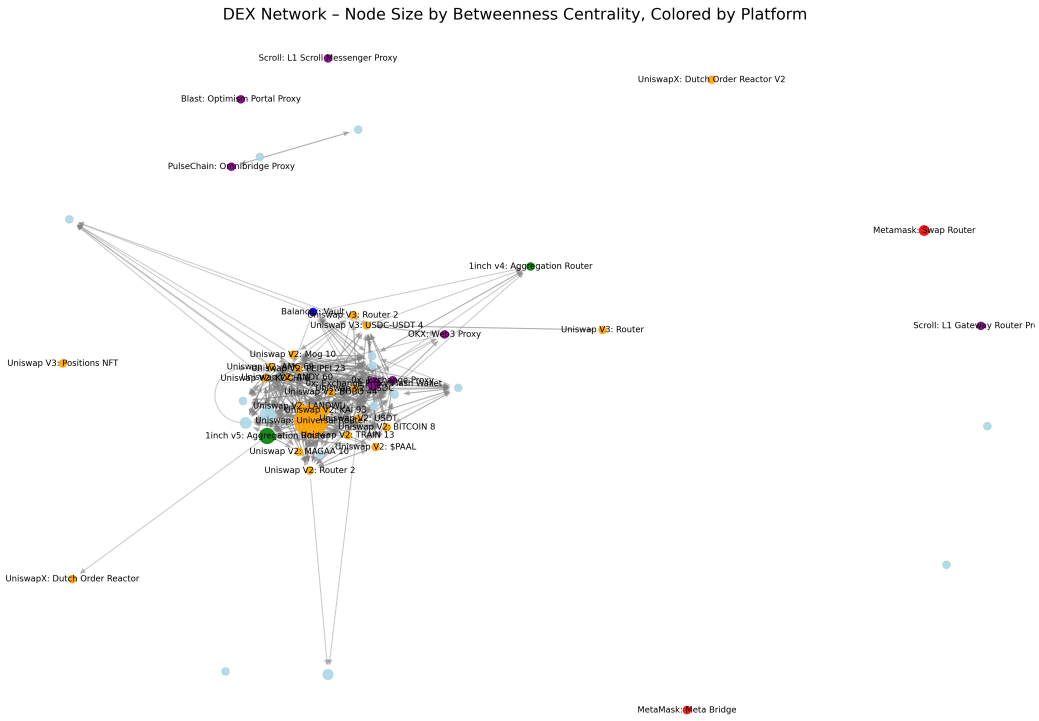


Figure 4: DEX Network – Node Size by Betweenness Centrality, Colored by Platform

Insight: This plot shows the top 50 most active wallets in the DEX token transfer network, where node size reflects betweenness centrality — a measure of how often a node lies on the shortest path between others. Each node is also colored by DeFi platform, allowing us to visually separate protocols like Uniswap (orange), 1inch (green), Ox (purple), and Metamask (red).

The visualization reveals that several Uniswap contracts sit at the heart of the network with both high connectivity and high centrality, confirming their structural importance as routing hubs. Some 1inch aggregators also appear central, but slightly less so than Uniswap nodes. Interestingly, protocols like Ox and Metamask appear more peripheral — they are active but not structurally dominant.

This perspective demonstrates that not all active nodes are equally important: some act as bridges across the network (high betweenness), while others may be involved in many transactions but remain at the edges of the interaction graph.

3.2 Uniswap-Only Token Transfer Subgraph - Dianni Adrei Estrada

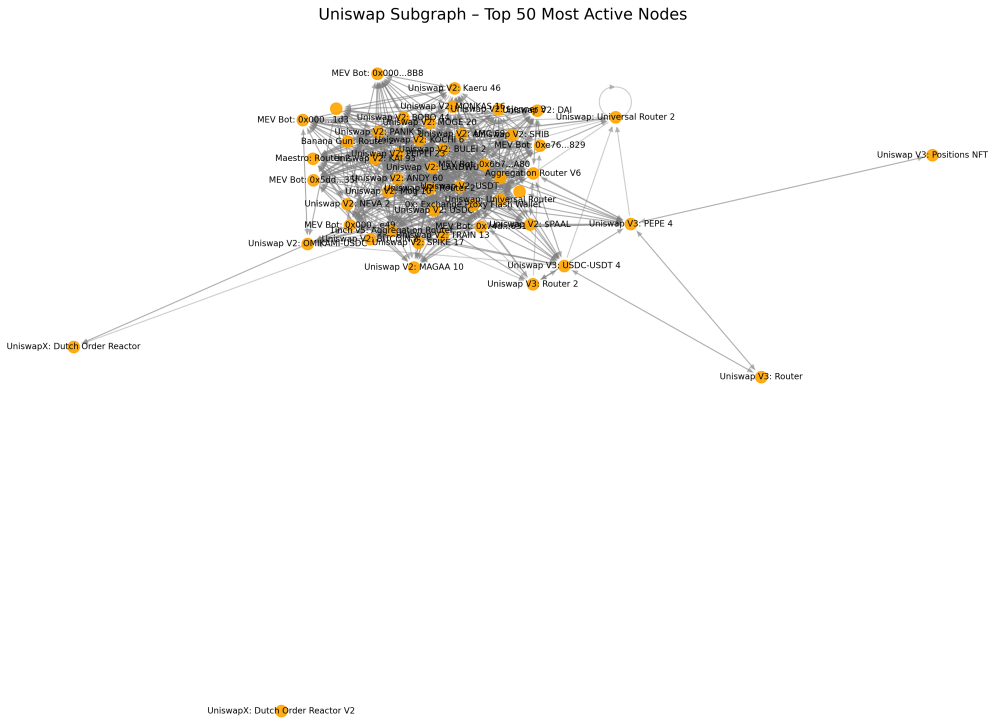


Figure 5: Uniswap Subgraph – Top 50 Most Active Nodes

Insight: This graph shows the top 50 most active addresses within the Uniswap ecosystem, filtered to include only transactions involving Uniswap contracts. Nodes are colored uniformly (orange) to represent the Uniswap protocol, and labeled using known entities from the dataset.

The resulting subgraph reveals a dense core of interconnected contracts, including Uniswap V2/V3 routers, pool management contracts, and aggregator-related addresses. Notably, contracts such as Uniswap: Universal Router 2 and Router 2 sit at the structural center, surrounded by peripheral wallets or specialized contracts like UniswapX: Dutch Order Reactor, which connects to the core but with fewer inbound links.

This visualization shows that although Uniswap is a decentralized exchange, its ecosystem exhibits semi-centralized routing behavior, where a few key contracts handle the majority of user interactions.

3.3 In-degree vs. Out-degree Scatter Plot (Log Scale) - Jiayi Wu

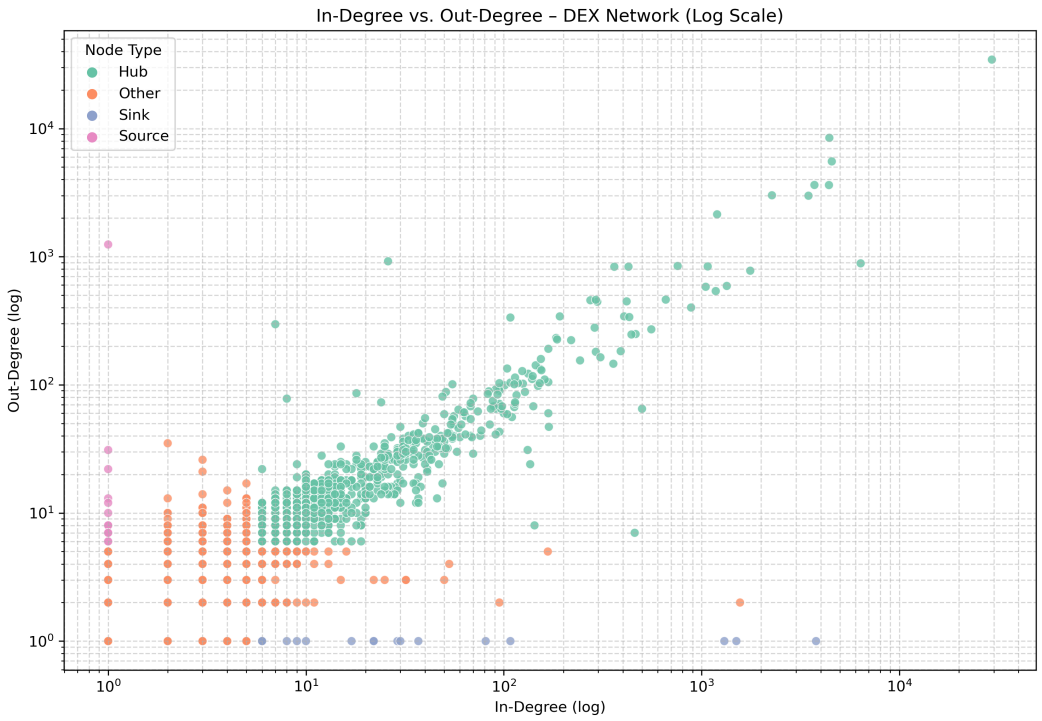


Figure 6: In-Degree vs. Out-Degree – DEX Network (Log Scale)

Insight: This scatter plot shows all nodes in the DEX transfer network, with their in-degree (number of wallets sending to them) on the x-axis and out-degree (wallets they send to) on the y-axis. The axes use logarithmic scales to reveal meaningful patterns across a wide range of activity levels.

Nodes are classified into types: sources, sinks, hubs, and others. Hubs (in green) follow a near-linear log-log trend, reflecting DEX smart contracts that both receive from and send to many wallets — such as Uniswap and 1inch routers. Sources (purple) show high out-degree and low in-degree, likely representing user wallets initiating trades. Sinks (blue) show the opposite pattern and may represent smart contracts or liquidity receivers.

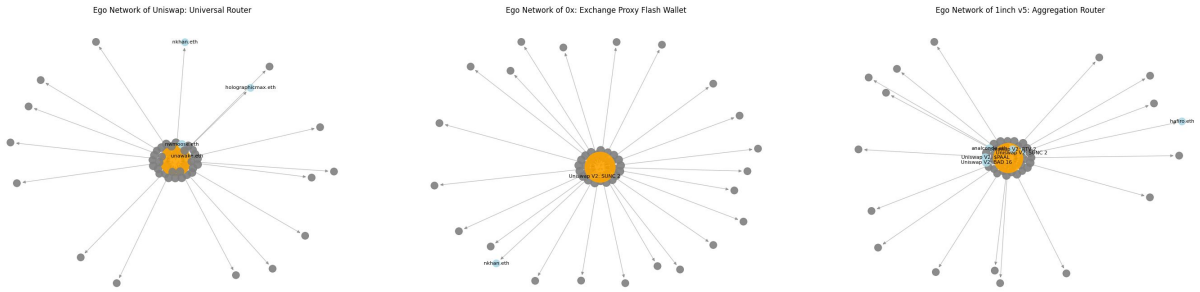
The plot confirms that the Ethereum DEX ecosystem is structurally centralized around a small group of hubs, while the vast majority of nodes are passive or single-purpose participants.

4 Account Analysis

In the context of this Ethereum token transfer network study, nodes were classified into three structural categories—hubs, bridges, and peripherals—based on their connectivity and centrality within the graph. Hubs are highly connected and influential nodes that facilitate large volumes of transactions across many counterparties; in this analysis, these included Uniswap: Universal Router (0x3fc9...7fad), 1inch v5: Aggregation Router (0x1111...0582),

and 0x: Exchange Proxy Flash Wallet (0x22f9...8c18), all of which exhibit exceptionally high degrees (over 10,000) and measurable betweenness centrality, indicating their central role in DeFi token flows. Bridges, by contrast, serve as intermediaries in cross-domain or protocol-to-protocol communication; selected examples such as Blast: L1 Bridge Proxy (0x3a05...9115), Blast: L1 Cross Domain Messenger Proxy, and Scroll: L1 WETH Gateway Proxy had moderate degrees (ranging from 5 to 86) and lower—but non-zero—betweenness, signaling their functional but less network-dominant position. Lastly, peripheral nodes are sparsely connected participants with minimal influence, often serving a single purpose such as storage, delegation, or contract creation; this group included DSProxy #162,695, voxelville-treasury.eth, and Uniswap Protocol: Permit2, each with a degree of just 1 and zero betweenness centrality. These classifications were determined through a combination of degree analysis and centrality measures, allowing for a comparative exploration of network behavior across roles.

4.1 Ego Network of Hub Accounts - Bianca Fernandes



(a) Hub Account 1 (b) Hub Account 2 (c) Hub Account 3

Figure 7: Ego Networks of High-Degree Hub Accounts

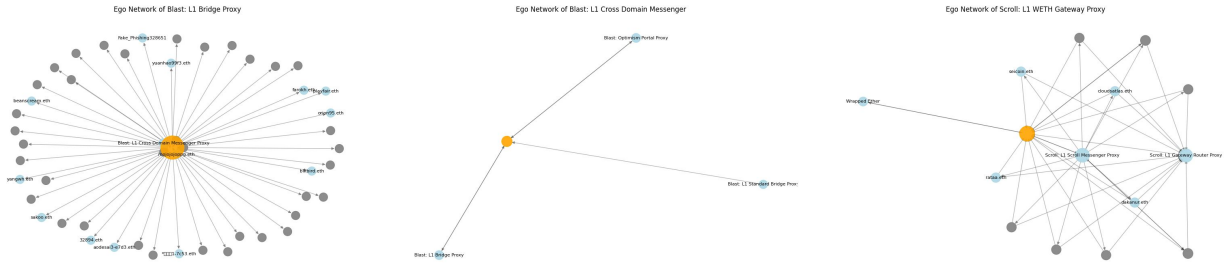
Based on the ego network visualizations of the three hub accounts—Uniswap: Universal Router, 0x: Exchange Proxy Flash Wallet, and 1inch v5: Aggregation Router—we can observe clear structural patterns and behavioral roles in the DEX network. Each of these nodes exhibits a classic hub-like structure, forming the central node in a radial graph of interactions with many smaller, peripheral accounts. The Uniswap Universal Router shows a dense inner core with multiple known addresses (e.g., unawake.eth, nwmoose.eth, holographicmax.eth), indicating that it interacts directly with a significant number of labeled participants. This suggests its central function in facilitating token swaps and aggregating liquidity across known and unknown users. Its ego graph also displays a symmetrical flow of connections, reinforcing its dual role as both sender and receiver in high-volume token flows.

The 0x Exchange Proxy Flash Wallet demonstrates a very similar radial pattern but with fewer visible labeled neighbors. Despite that, its ego structure remains highly symmetrical, with most of the nodes connected directly to the center and minimal interconnectivity among neighbors. This suggests that 0x acts more like a clearing or routing intermediary, processing numerous discrete transactions likely on behalf of external dApps or aggregators. The presence of nkhan.eth as a labeled neighbor reinforces its public or institutional usage.

The 1inch v5 Aggregation Router shows a more clustered center with some overlapping node labels, including multiple Uniswap liquidity pool contracts and aggregator components such as "Uniswap V2: SPAAL," "BAD 16," and others. This dense overlap within the core implies high-frequency interaction with other smart contracts or infrastructure nodes, making it likely that 1inch not only routes transactions but also initiates smart contract-based operations. The presence of some labeled individual addresses like hafiro.eth also hints at end-user interactions.

Taken together, these three ego networks confirm the structural hypothesis that DEX routers function as highly connected hubs within the Ethereum token transfer network. Their interaction patterns suggest high throughput, multi-token routing, and tight coupling with both user-facing interfaces and backend liquidity infrastructure. Their central roles are not just architectural, but behavioral, acting as nexus points that help glue the wider DeFi ecosystem together

4.2 Ego Network of Bridge Accounts - Dianni Adrei Estrada



(a) Bridge Account 1 (b) Bridge Account 2 (c) Bridge Account 3

Figure 8: Ego Networks of Cross-Chain Bridge Accounts

Based on the ego network visualizations of the bridge group—Scroll: L1 WETH Gateway Proxy, Blast: L1 Cross Domain Messenger, and Blast: L1 Bridge Proxy—we can observe distinct functional behaviors that reflect their roles as intermediaries in cross-chain communication or asset bridging protocols. The Scroll: L1 WETH Gateway Proxy presents a denser and more interconnected ego network than typically expected for a bridge component. It is not only linked to utility contracts like "Wrapped Ether" and its sibling components such as the Scroll L1 Messenger and Router, but also interacts with a surprisingly diverse set of labeled addresses such as rataa.eth, cloudsatlas.eth, and dakanur.eth. This suggests that the Scroll Gateway participates in more than just passive transfers and may be actively facilitating user-initiated bridging flows, likely involving WETH liquidity movement between chains or L1-to-L2 settlements. The presence of multiple smart contracts and named wallets in the ego network points to deeper integration into DeFi transaction paths, distinguishing it as a slightly more active node than the average bridge.

In contrast, the Blast: L1 Cross Domain Messenger exhibits a much more constrained and focused structure, with direct links only to three other contracts, all of which are part of the Blast bridging system (such as the Optimism Portal and Standard Bridge Proxy). This

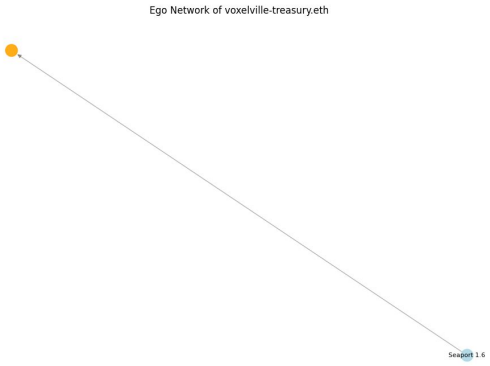
tightly bound ego network reinforces its architectural specialization as a message-passing mechanism rather than a token-transfer endpoint. Its isolation from broader address sets and low node count imply that it operates strictly behind the scenes in a protocol-level function, enabling state synchronization rather than liquidity movement.

The most active among the group, however, is the Blast: L1 Bridge Proxy, whose ego network reveals a star-like hub structure with dozens of outgoing edges to a large number of user-labeled wallets. Names like farokh.eth, beanscream.eth, playfair.eth, and mojojojo.eth indicate active engagement with a wide user base, suggesting this bridge component serves as a primary entry/exit point for users bridging assets to and from the Blast L2. The connection to Blast: L1 Cross Domain Messenger in the center further confirms its role in initiating bridge operations. This structure not only highlights the bridge's prominence but also places it close to the functional perimeter of the DeFi ecosystem—interacting both with protocol infrastructure and end-users alike.

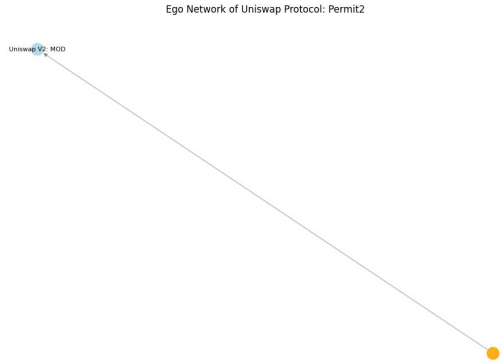
Together, these three bridge nodes illustrate a spectrum of bridging behavior: from infrastructural relay (Cross Domain Messenger), to hybrid role (Scroll WETH Gateway), to high-volume user-facing bridge (Blast Bridge Proxy). This diversity underlines that not all bridge contracts behave equally—some remain deeply embedded and silent, while others emerge as transaction hubs critical to ecosystem connectivity.

4.3 Ego Network of Peripheral Accounts - Jiayi Wu

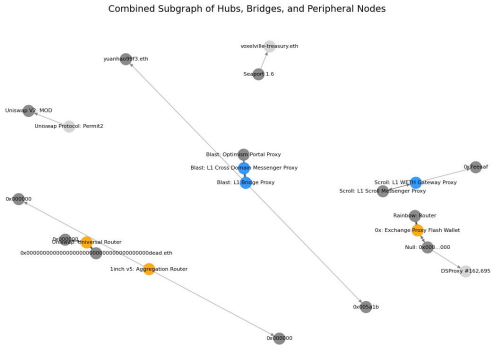
(a) Ego Network of Peripheral Accounts - 1



(b) Ego Network of Peripheral Accounts - 2



(c) Ego Network of Peripheral Accounts - 3



(d) Ego Network of Peripheral Accounts - 4

Figure 9: Ego Networks of Selected Peripheral Accounts

Based on the ego network visualizations of the three peripheral accounts—Uniswap Protocol: Permit2, voxelville-treasury.eth, and DSProxy #162,695—we see clear evidence of limited activity, specialized usage, and highly constrained network connectivity, which is typical of structurally peripheral nodes in decentralized networks. The Uniswap Protocol: Permit2 account displays a singular outgoing connection to a Uniswap V2 contract labeled "MOD," suggesting that its function is highly specialized and likely tied to a one-time interaction or approval delegation. The absence of additional nodes or returns implies this account is not used for regular transfer activity but rather serves a protocol-level utility, possibly handling token allowances or access permissions in the Uniswap ecosystem without participating directly in token exchange.

The ego network for voxelville-treasury.eth is similarly sparse, revealing just a single incoming interaction from a known contract labeled "Seaport 1.6." This indicates that the voxelville address functions more like a passive recipient or a vault, possibly for NFTs or DAO-managed assets rather than actively moving tokens. Its network position—far removed from other hubs or active nodes—supports the interpretation that this address represents

a treasury or long-term storage entity, consistent with the naming convention and smart contract interaction pattern.

Lastly, DSProxy #162,695 reveals one of the most archetypal peripheral structures: it is connected in a single edge with the null address (0x000...000), which strongly suggests it was involved in a creation or self-destruct transaction. DSProxy contracts are commonly used in MakerDAO and DeFi platforms to encapsulate user operations like opening vaults or managing positions. The one-directional flow and total isolation from any other address in the ego view emphasize that this proxy may have only been used once or was created and then decommissioned.

Altogether, these three peripheral ego networks illustrate minimal token flow, tightly scoped functional roles, and non-redundant interactions, reinforcing their classification as peripheral nodes in the token transfer graph. Their behaviors contrast starkly with the hub and bridge nodes, which are characterized by high connectivity, transactional volume, and strategic placement within the network's core. These peripheral accounts, by comparison, serve either administrative, custodial, or single-purpose transactional roles at the edges of the ecosystem.

The combined subgraph of hubs, bridges, and peripheral nodes reveals a fragmented but informative snapshot of Ethereum's token transfer infrastructure, illustrating how different structural roles operate and connect within the broader ecosystem. The hub nodes, including Uniswap's Universal Router, 1inch's Aggregation Router, and 0x's Proxy Wallet, are visibly more central, with multiple edges and connections to utility addresses and other major protocols. Bridges such as the Blast L1 Bridge Proxy and Scroll's Gateway Proxy appear as modestly connected intermediaries, mostly linking to known contracts like cross-domain messengers or wrapped token handlers, reinforcing their role as protocol-level conduits rather than user-facing components. In contrast, the peripheral nodes—Uniswap Permit2, voxelville-treasury.eth, and DSProxy—are highly isolated, each connected to only one or two other nodes, typically utility contracts or creation events, reflecting their narrow, often one-time-use purpose. The layout underscores how hubs serve as critical infrastructure with broad interactions, bridges occupy a functional relay position between chains, and peripheral nodes sit at the edges, engaging in limited, specialized tasks.

5 Conclusion

Our network analysis of Ethereum's DEX-based token transfers uncovers a highly asymmetric and functionally stratified ecosystem. Centrality measures and visualizations consistently highlight the dominance of a few highly connected nodes, particularly Uniswap routers, which serve as pivotal liquidity hubs. These entities act not only as major transaction endpoints but also as bridges that interconnect otherwise separate parts of the DeFi landscape.

Bridge nodes, while less central than DEX hubs, demonstrate specialized behaviors that vary based on their integration level and intended function. Some, like the Blast L1 Bridge Proxy, act as active gateways for cross-chain user transactions, while others, such as domain messengers, operate silently within the protocol infrastructure. Peripheral nodes, by contrast, tend to have narrow scopes of use—often involved in specific, one-time transactions such as vault creation or token delegation.

Taken together, the Ethereum token transfer network exhibits a semi-centralized topology within a decentralized protocol. While the system allows open participation, operational control and liquidity flow remain concentrated among a few well-established smart contracts. This raises important considerations for protocol design, resilience, and user access in the evolving DeFi ecosystem. Future work may expand this approach to longitudinal analyses, cross-chain interactions, and anomaly detection to further refine our understanding of decentralized token flows.