iNET Seminar

A Framework for Nation-Centric Classification and Observation of the Internet

Sebastian Meiling

Outline

- ***Introduction***
- Methods
- Results
- Summary & Outlook

Introduction

- Internet is a critical infrastructure
  - Countries & governments
  - National & global economy
- Internet usage
  - Communication
  - Information source
  - Market place
  - Business model
  - ...

But ...

- The Internet is also subject to
  - Censorship & surveillance
  - National laws & policies
  - Attacks & crime
- Upcoming questions
  - How (well) is the connectivity of a country?
  - Who are important players in the Net?
  - What is the visualization and structure of a national Internet topology graph

Internet Building Blocks

- BGP inter-connects Autonomous Systems (AS)
  - Each AS maintains one or more IP prefixes
  - An IP prefix consists of one or more IP blocks
  - An IP block is a range of IP addresses allocated by one organization (situated in a certain country)
- IP blocks are governed by regional registrars (RIRs)
  - RIPE NCC, ARIN, APNIC, AFRINIC, and LACNIC
- Relationship between Internet topology and geography
- IP blocks/addresses offer appropriate granularity to discover country-wise (all) Internet players

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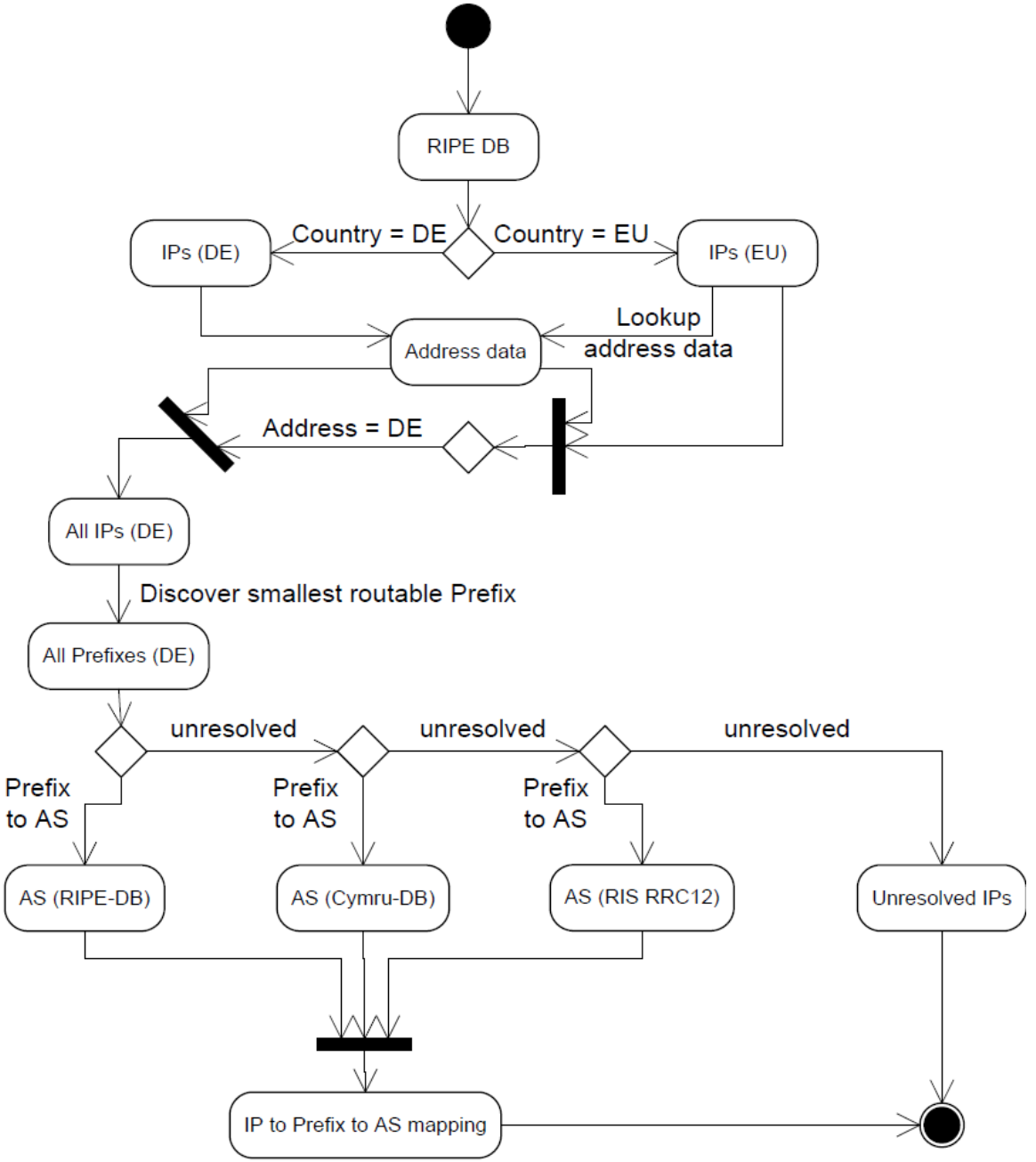
From IP address to AS number

- Identify all IP blocks of a specific country
  - query regional databases and BGP route monitors
  - for Germany: RIPE DB and RIPE RIS
- Map IP blocks to smallest enclosing prefix
- Resolve IP prefixes to AS numbers
- Retrieve additional AS information
  - AS name, owning company, address data

Toolchain


RIPE DB
IPs (DE)
Country = DE
Country = EU
IPs (EU)
Address data
Lookup
address data
Address = DE
All IPs (DE)
Discover smallest routable Prefix
All Prefixes (DE)
unresolved
unresolved
unresolved
Prefix
to AS
Prefix
to AS
Prefix
to AS
AS (RIPE-DB)
AS (Cymru-DB)
AS (RIS RRC12)
Unresolved IPs
IP to Prefix to AS mapping

Classification

- Topological category
  - Based on classification by UCLA
  - Tier1, large and small ISP, stub

- Business branches/sectors
  - keyword filter, manually refined
  - ISP, peering points, Traders, industry, research and education, government, and others

Problems

- Inconsistent or incomplete DB entries
- Restricted access to certain information
- Unresolvable IP blocks
- Conflicting mappings between different DB
- Special case: EU countries need additional filtering on address data keywords
- Manual refinement of keywords

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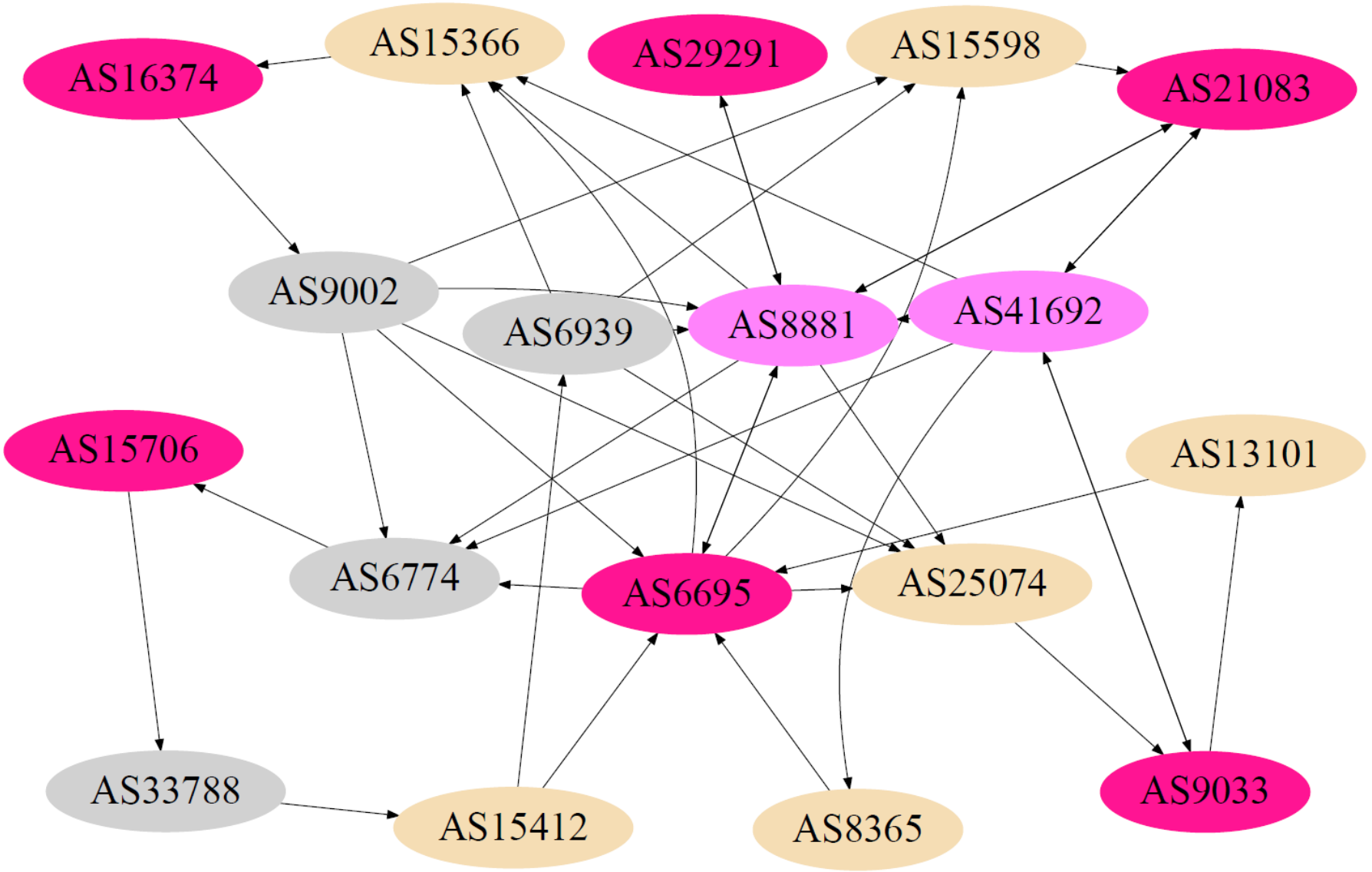
In numbers

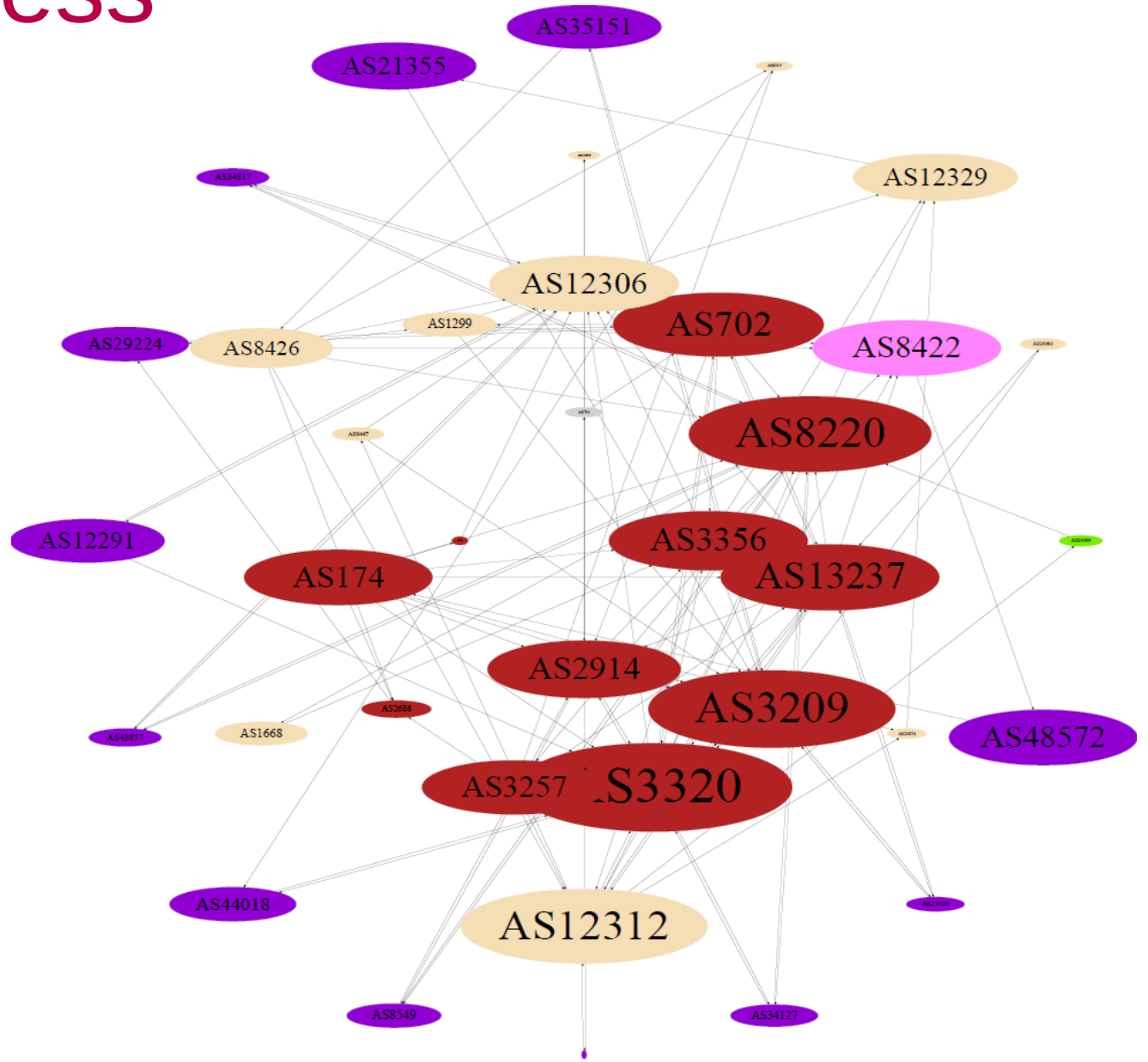
- Identified 245524 *German* IP-blocks
  - 240237 embedded in 6278 IP-prefixes
  - Prefixes mapped to 1472 ASes
  - 5286 IP-blocks remained unresolved (≈ 2%)
- IP-block vs. IP-prefix:

	DE	**EU**	**other**
(our) IP-block approach	6278		
IP-prefix approach (RIPE DB)	5243		1035
IP-prefix approach (Team Cymru)	4395	947	936

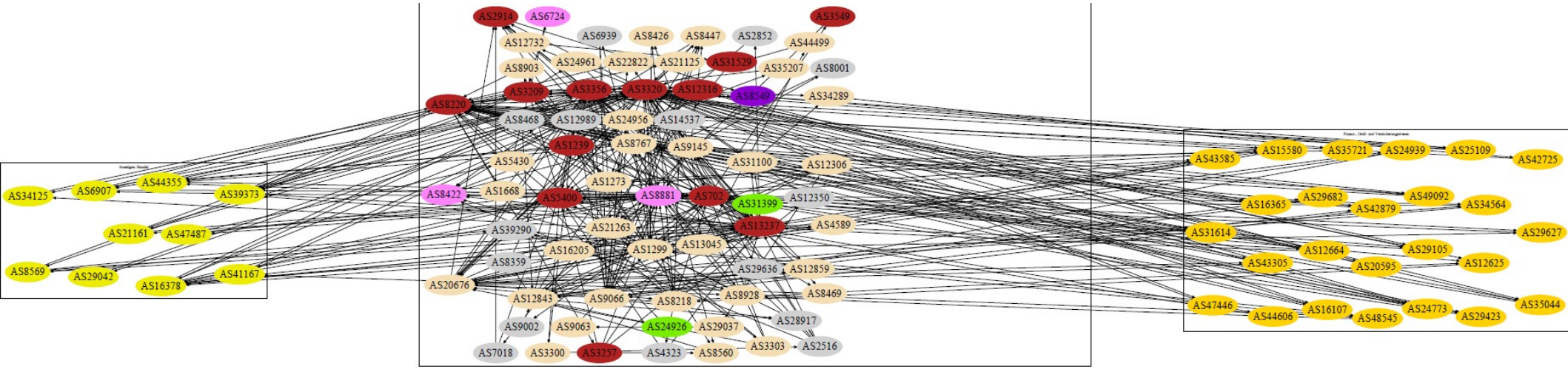
Internet Exchange Points



Betweenness



Traders and financial services



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Summary

- Tool chain to identify a nation-centric Internet
  - demonstrated for Germany
  - special case: EU country
- Method starts from IP-blocks
  - not from prefixes, like others
  - identifies more *German* ASes
- Sector filter
  - sort ASes into business branches
  - analysis of AS relations

Outlook

- Apply regular updates
- Test and verify the methods and toolchain against other countries
- (How) do the results differ?

References

[1] J.Karlin, S.Forrest and J.Rexford, *“Nation-State Routing: Censorship, Wiretapping, and BGP”,* Tech.Rep. 2009

[2] M.Wählisch, S.Meiling, and T.C.Schmidt, *“A Framework for Nation-Centric Routing and Observation of the Internet”*, CoNEXT'10 Student Workshop

[3] M.Wählisch, T.C.Schmidt, S.Meiling, Markus de Brün, and Thomas Häberlen, *“Towards a Nation-Centric Understanding of the Internet”*, CoNEXT'10 Student Workshop

[4] B.Zhang, R.Liu, D.Massey, and L.Zhang, *“Collecting the Internet AS-Level Topology”*, Comp.Comm.Rev. 2005