

Exposing the Complexity of the AS Relationships

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- **BGP routing = topology + policies**
- AS Relationships: determine how routes are imported and exported
- Why reheat an old subject?
 - AS Relationship datasets are conflicting
 - Simulations yield poor results

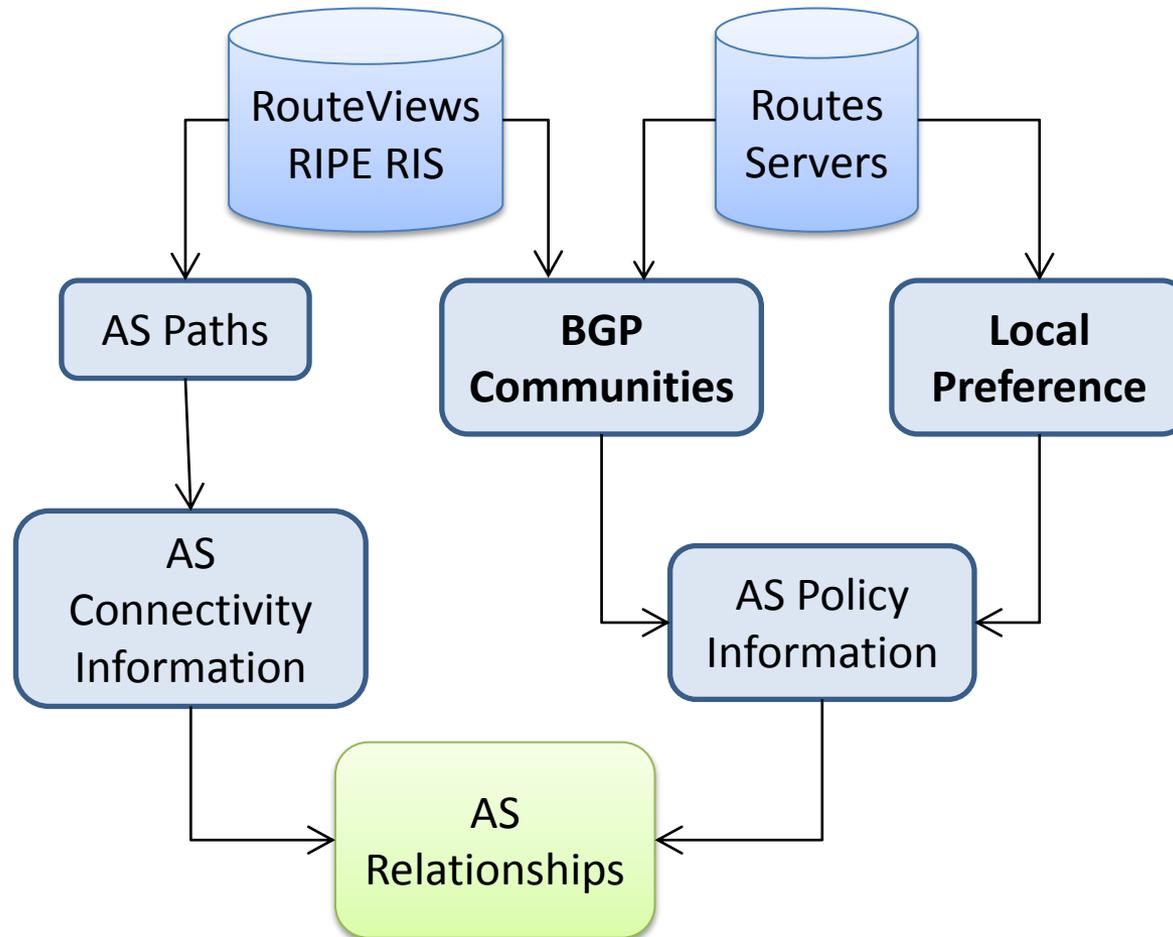
Challenges

- Inference from topology data → **Heuristics**
- Ground-truth information is hard to find → **Difficult evaluation**
- Fundamental structural changes (hierarchical to flat, IXPs , densification) → **Re-evaluation of existing algorithms**
- Two “parallel” Internets (IPv4/IPv6) → **Separate inference**

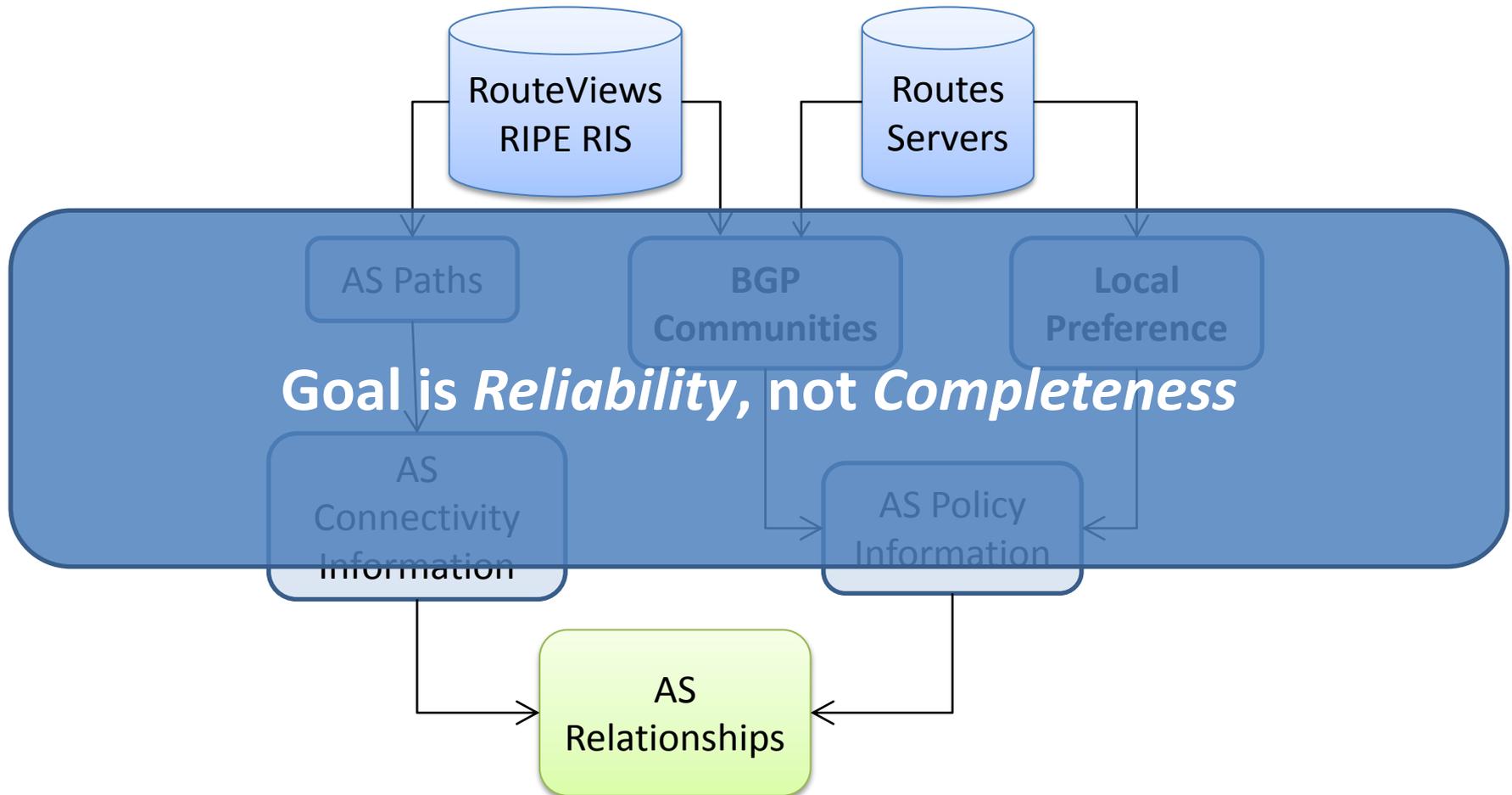
Goals

- Rigorous analysis of BGP attributes that express policy information
 - Communities
 - Local Preference
- Try to infer complex relationship types
 - p2c, p2p, s2s
 - hybrid, indirect peering, partial-transit, backup

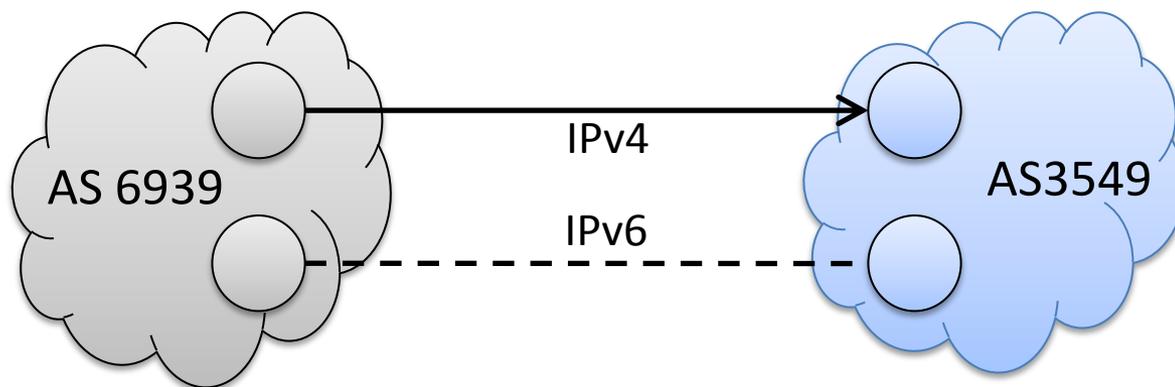
Methodology



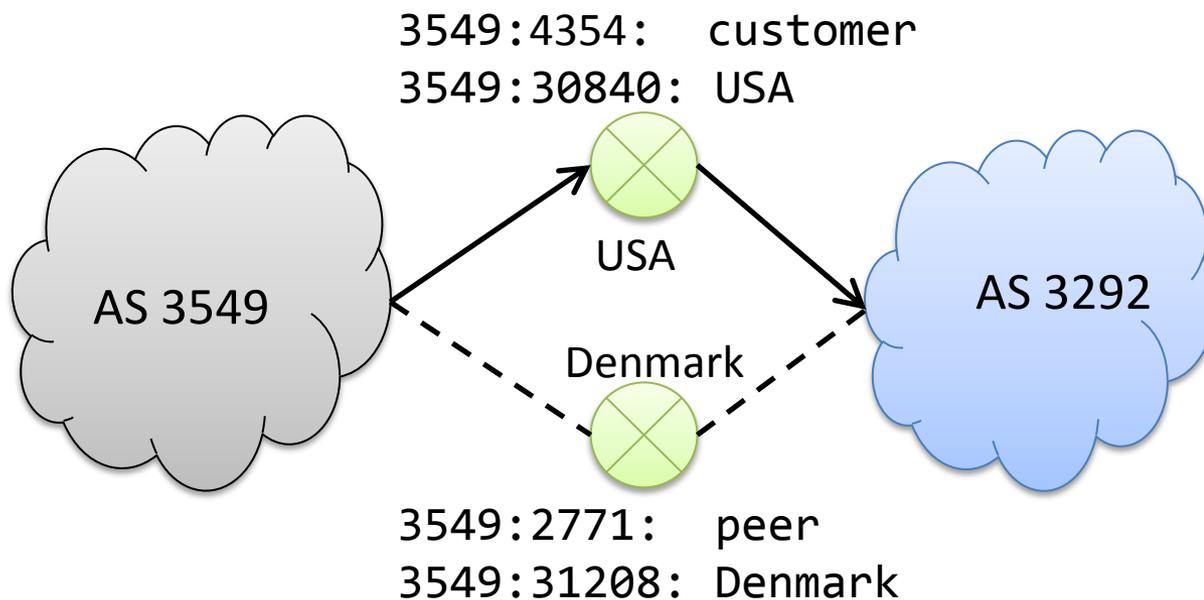
Methodology



Hybrid Relationships

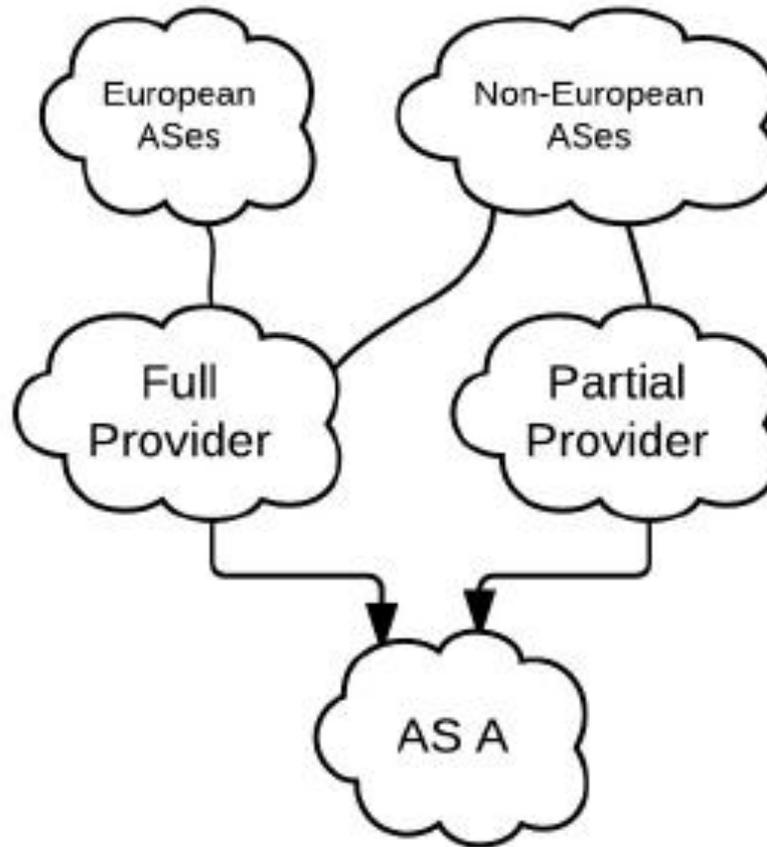


IP-version depended

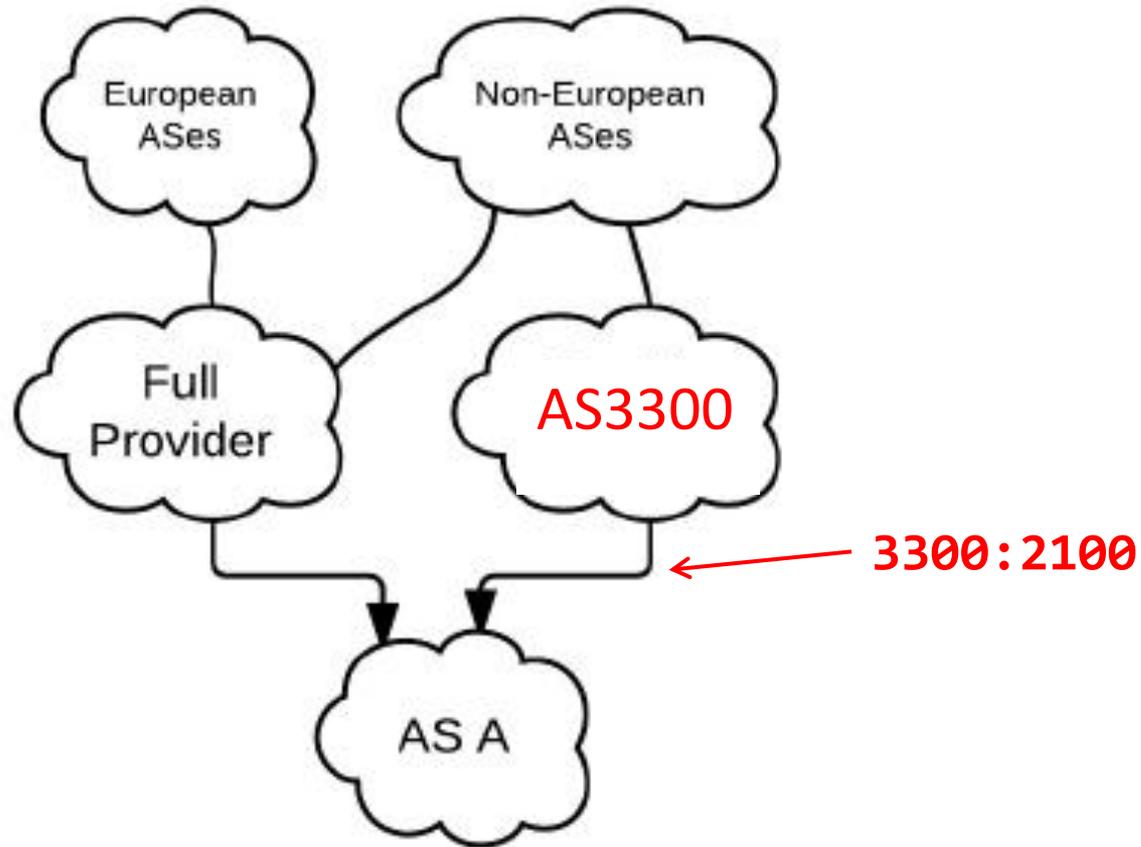


Location depended

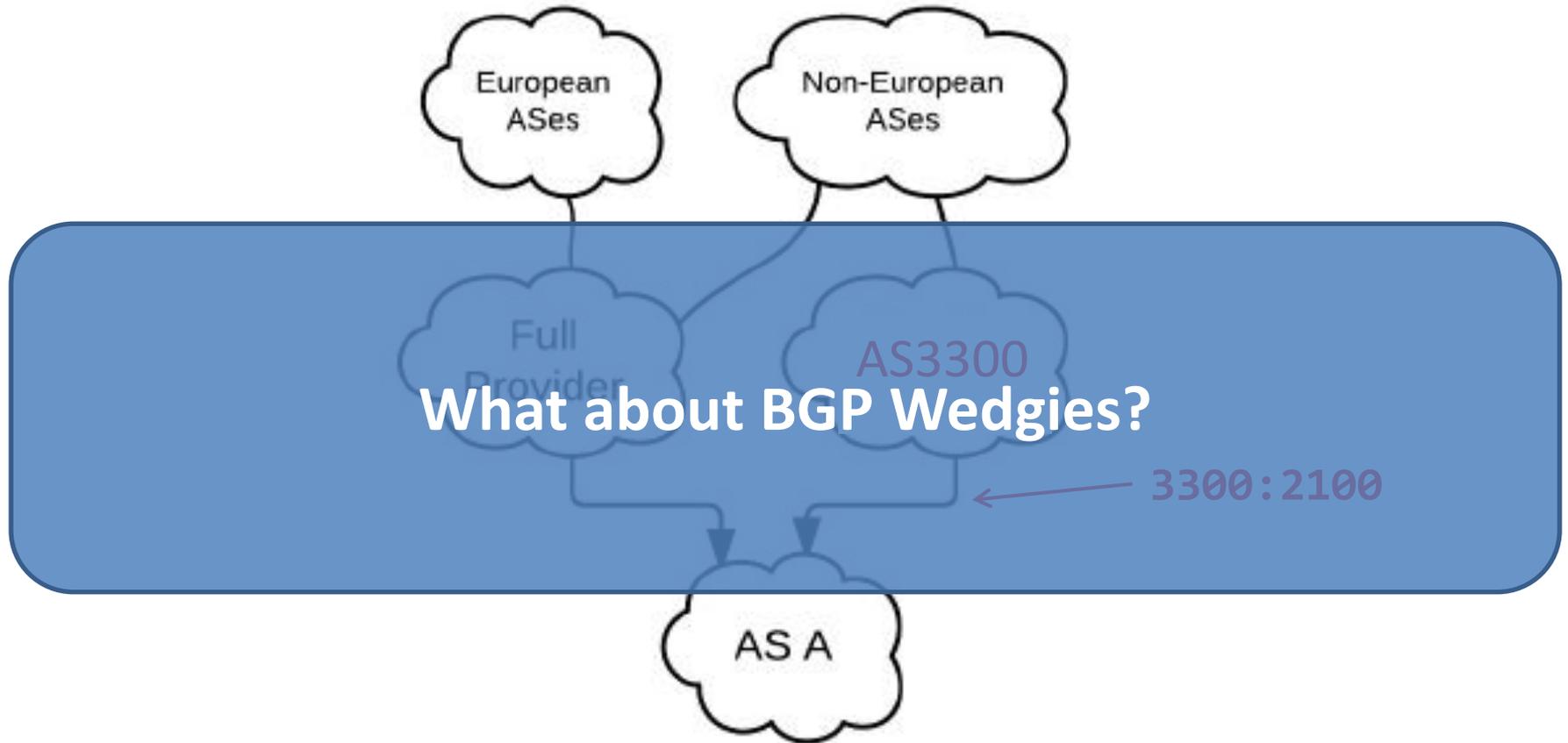
Partial Transit



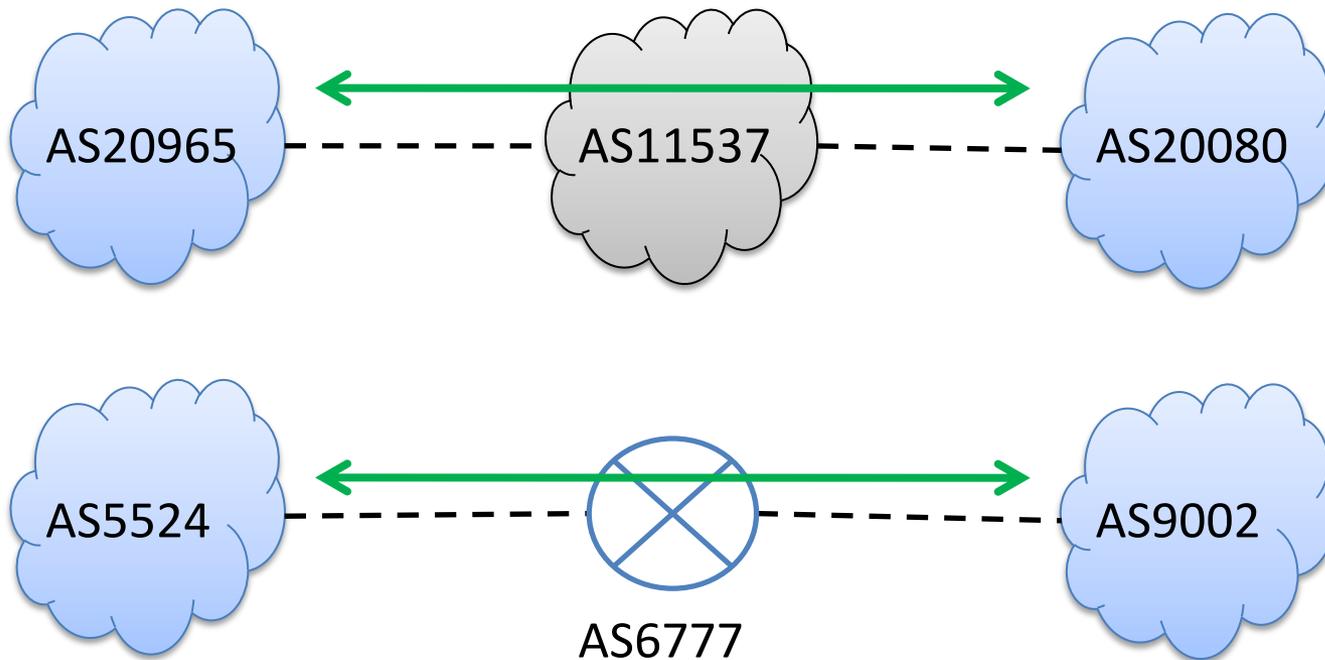
Partial Transit



Partial Transit



Indirect Peering



Educational/research
Networks
(e.g. Internet2)

Public peering at IXPs
(e.g. AMS-IX)

Results (February 2011)



	IPv4	IPv6
Number of AS Links	109,807	10,535
Inferred Relationships	42,385 (39%)	7,651 (72%)
Relationship Type	IPv4 & IPv6	
P2C	26,075	
P2P	18,603	
S2S	177	
Hybrid Links	1,034	
Indirect peering	811	
Partial transit	1,828	
Backup transit	1,205	

IPv6 Relationships



- 13% of the AS links that serve both IPv4 and IPv6 are hybrid
- 47% of the IPv6 AS paths contain at least one AS link with hybrid IPv4/IPv6 relationship
- Around 10% of the IPv6 AS paths are non valley-free (daily)
 - 11% during the IPv6 World Day

Conclusions/Future Work



- Unexploited wealth of policy information
- Complex relationship types become increasingly popular
- IPv6 relationships should be studied separately (at least until convergence)

- Extend the interpretation of Communities values
- Extend to 100% of AS links
- Combine BGP/traceroute data
- Performance impact on IPv6

Thank you!