

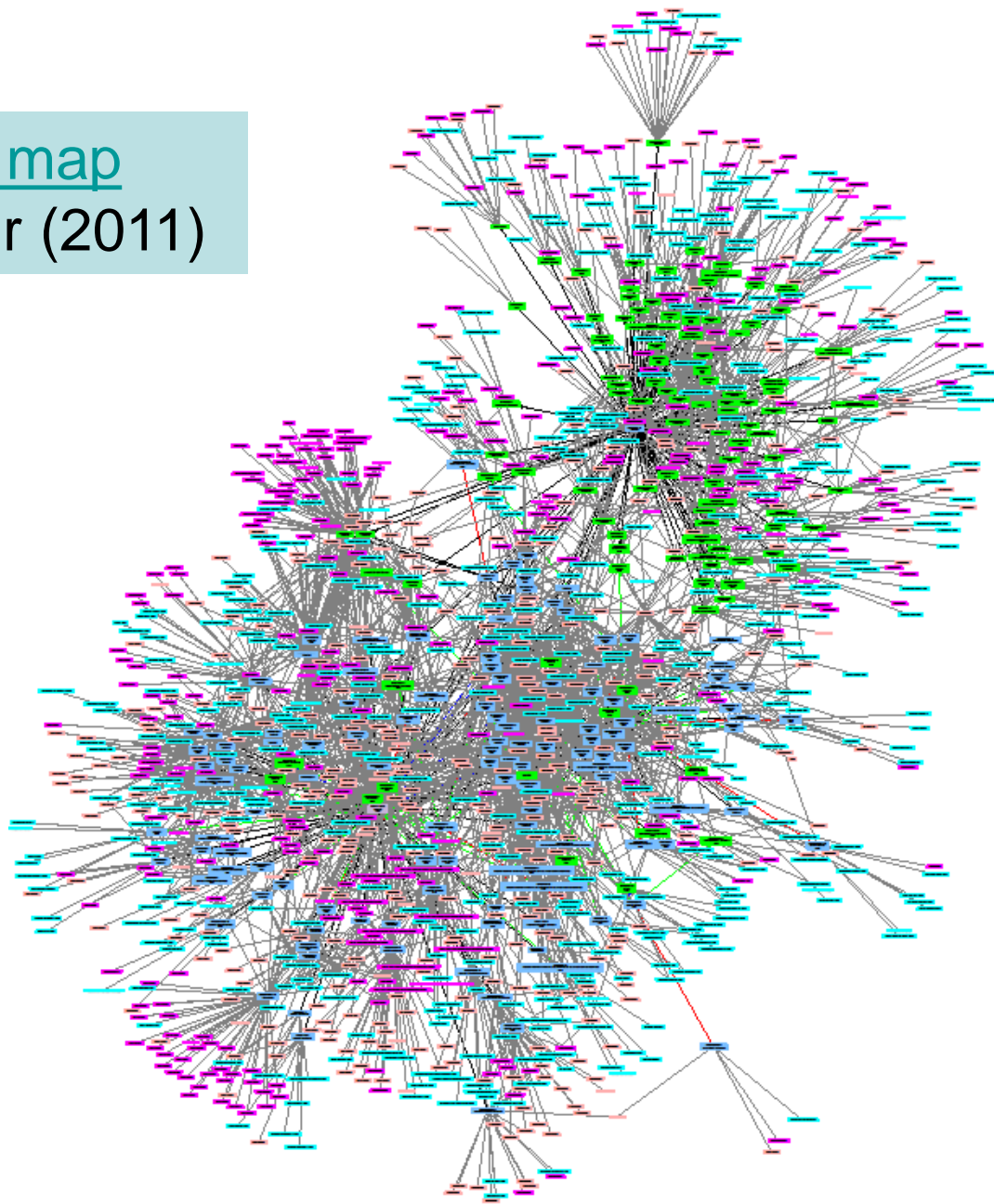


Topic 12: **Citation and other network analysis**

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Citation map
Ritonavir (2011)



Overview

- Collaboration networks
- Citation networks
 - Key patents
 - Innovation tracks

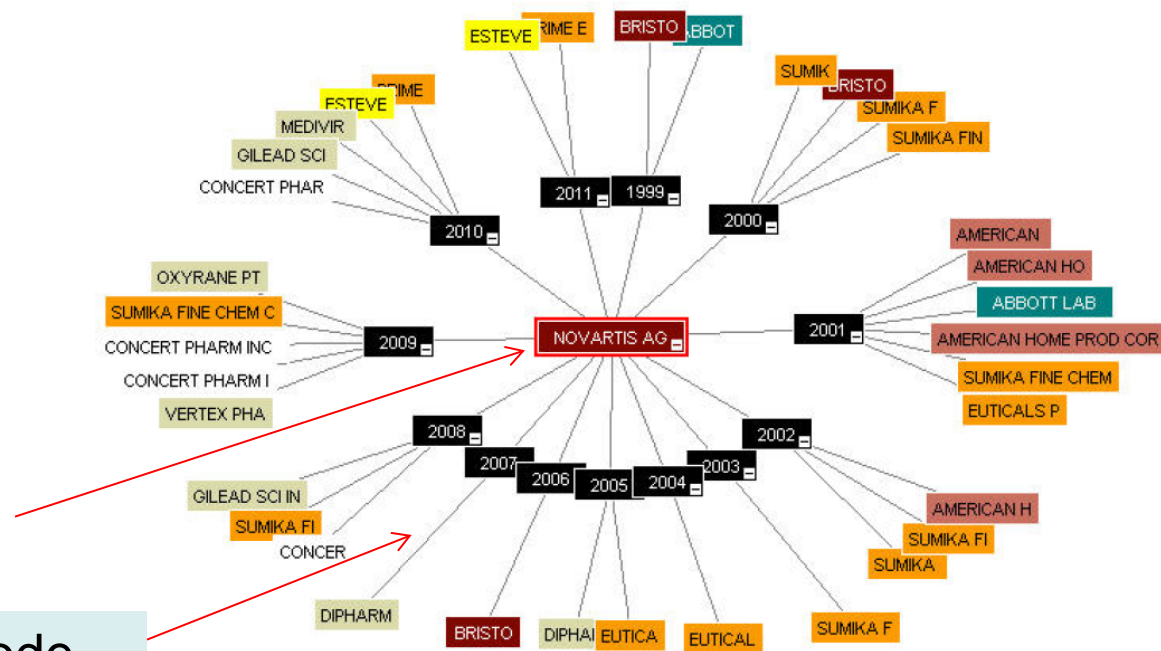
Network map

Entities, e.g. applicants, inventors, documents, are connected to each other in the form of a node and link diagram, e.g.

- Collaboration map

- Citation map

- What is this one ?



“Node”; here “root” node

“link”, “edge” between node

INTERMEDIATE MAKING	OWNER	COMPETITOR
SYNTHESIS METHOD	NOT HIV	PROPOSED CMPD
	NOT ANNOTATED	

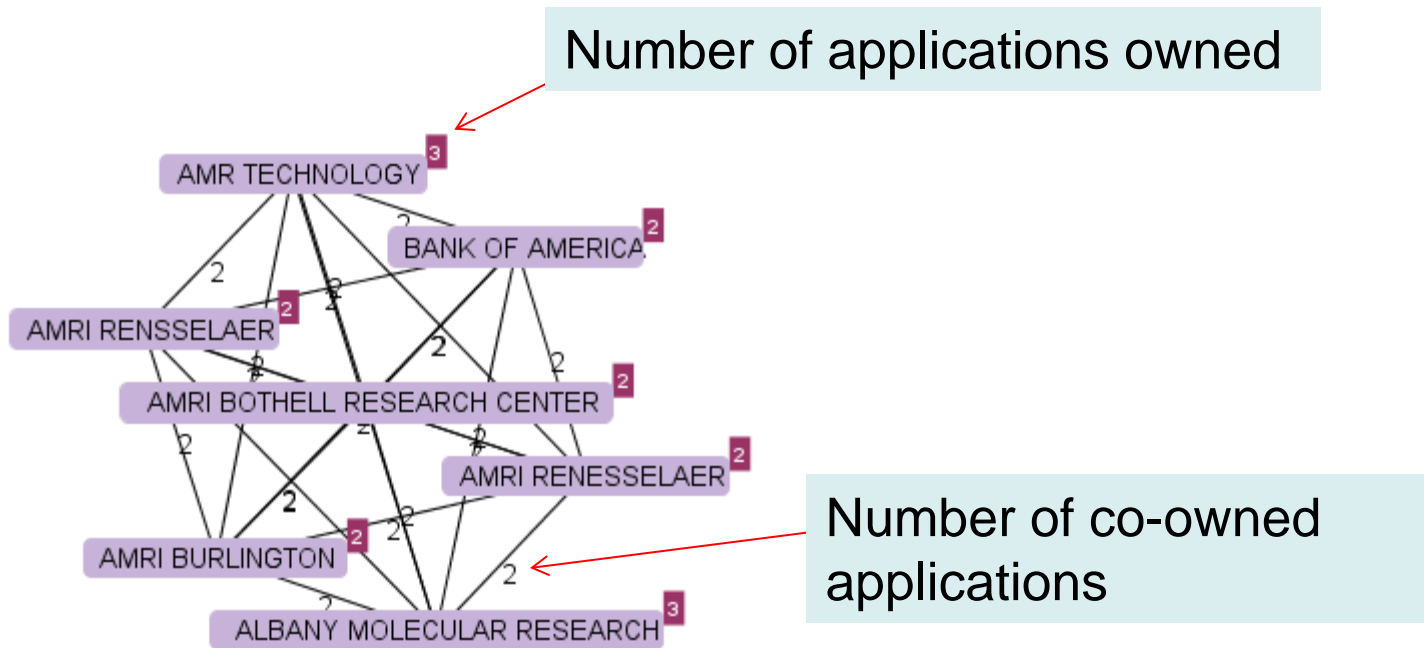
Collaboration networks

- Graphs modelling social networks, collaborations between
 - Inventors (individuals, affiliated e.g. with corporations)
 - Applicants/assignees (corporations)
- Analysis of co-occurrences of names
 - Meaningful analysis requires cleaning/grouping of names
 - Example Ritonavir [visualization](#)
 - Visualizations can also be used for cleaning/groupings
- Co-occurrences do not necessarily imply collaboration in development, they primarily indicate co-ownership
- Assignee/applicant/owner names may change
- Inventor names do not change

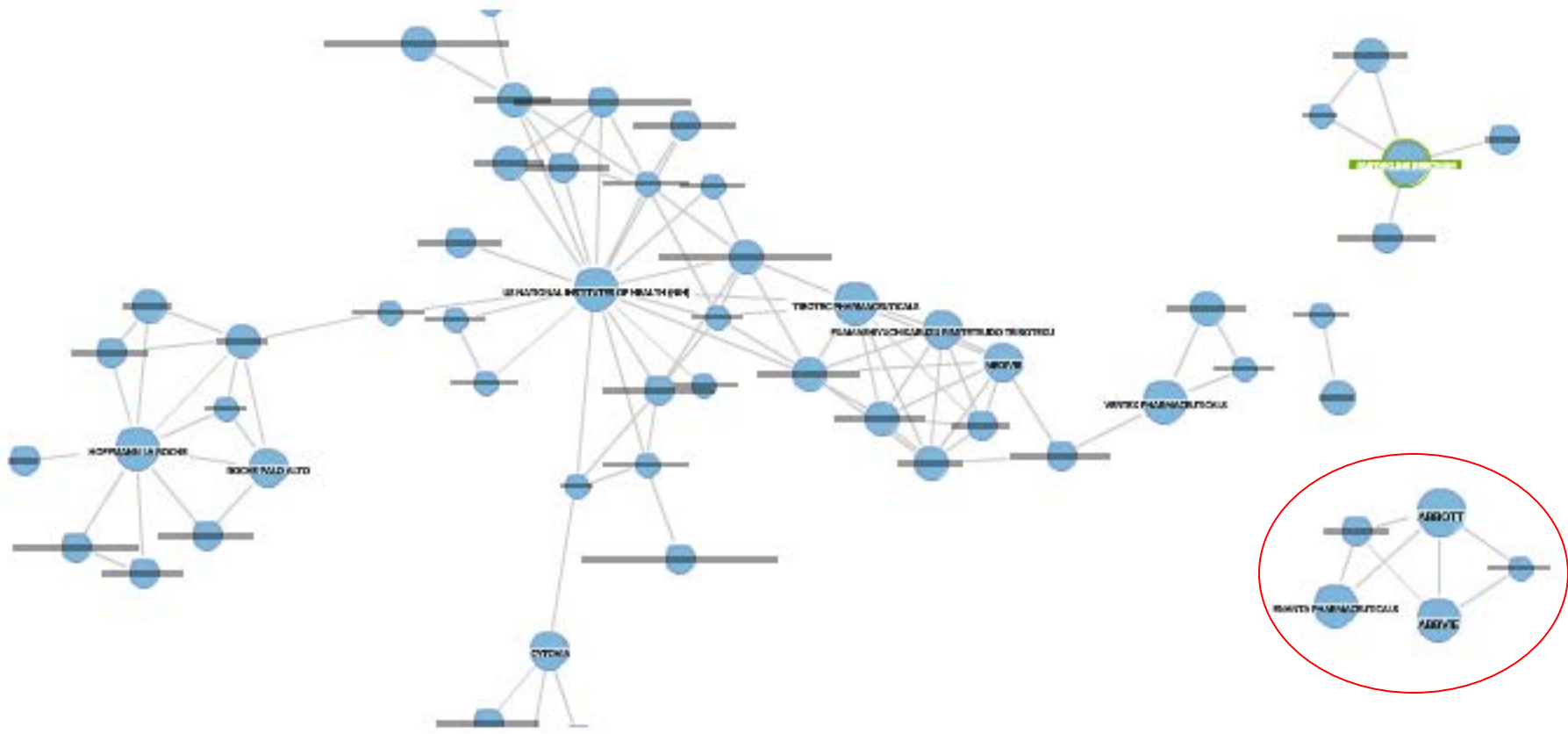
Co-occurrence matrix (applicants)

		Investigator (Cleaned)																												
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
		# Records	22	15	15	9	7	7	6	6	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	
Investigator (Cleaned)	# Records	1																												
			VARNEY, M D	PALMER, C L	ROMINES, W H	REICH, S H	BENDER, S L	WEBBER, S E	WHITTEN, K R	ALBIZATI, K F	LING, A L	DRAGOVICH, P S	PRINS, T J	DEAL, J G	BUSSE, J K	REMARCHUK, T P	SZENDROI, R J	JONES, T R	TRUESDALE, L K	HONG, Y	DEASON, M E	MADSEN, P	LAU, J	KIEL, D	CASTELHANO, A L	BABU, S	BORER, B C	SAMS, C	TENG, M	KUKI, A
1	22	VARNEY, M D	22	15	14	3		3	2					3			3													
2	15	PALMER, C L	15	15	13									3			1													
3	15	ROMINES, W H	14	13	15									1			1													
4	9	REICH, S H	3			9		1	2		1	1																		1
5	7	BENDER, S L					7							2						1				3						
6	7	WEBBER, S E	3		1			7				3	3				2				1									
7	6	WHITTEN, K R							6	4					4	4	4				2					4	4			
8	6	ALBIZATI, K F	WEBBER, S E	2		2			4	6					4	4	4								4	4				
9	5	LING, A L									5								3	3		3	3	3				3	2	3
10	5	DRAGOVICH, P S				1		3				5	5																	
11	5	PRINS, T J				1		3				5	5																	
12	5	DEAL, J G	3	3	1		2							5											2					
13	4	BUSSE, J K							4	4					4	4	4									4	4			
14	4	REMARCHUK, T P							4	4					4	4	4									4	4			
15	4	SZENDROI, R J							4	4					4	4	4									4	4			
16	4	JONES, T R	3	1	1			2						1				4												
17	4	TRUESDALE, L K									3								4	1		3	3	3				2	2	2
18	4	HONG, Y									3								1	4		1	1	2				1	2	2
19	4	DEASON, M E					1		2												4									
20	4	MADSEN, P									3											4	4	3				3	2	2
21	4	LAU, J									3									3	1		4	4	3			3	2	2
22	4	KIEL, D									3									3	2		3	3	4					
23	4	CASTELHANO, A L					3							2											4					
24	4	BABU, S							4	4					4	4	4									4	4			

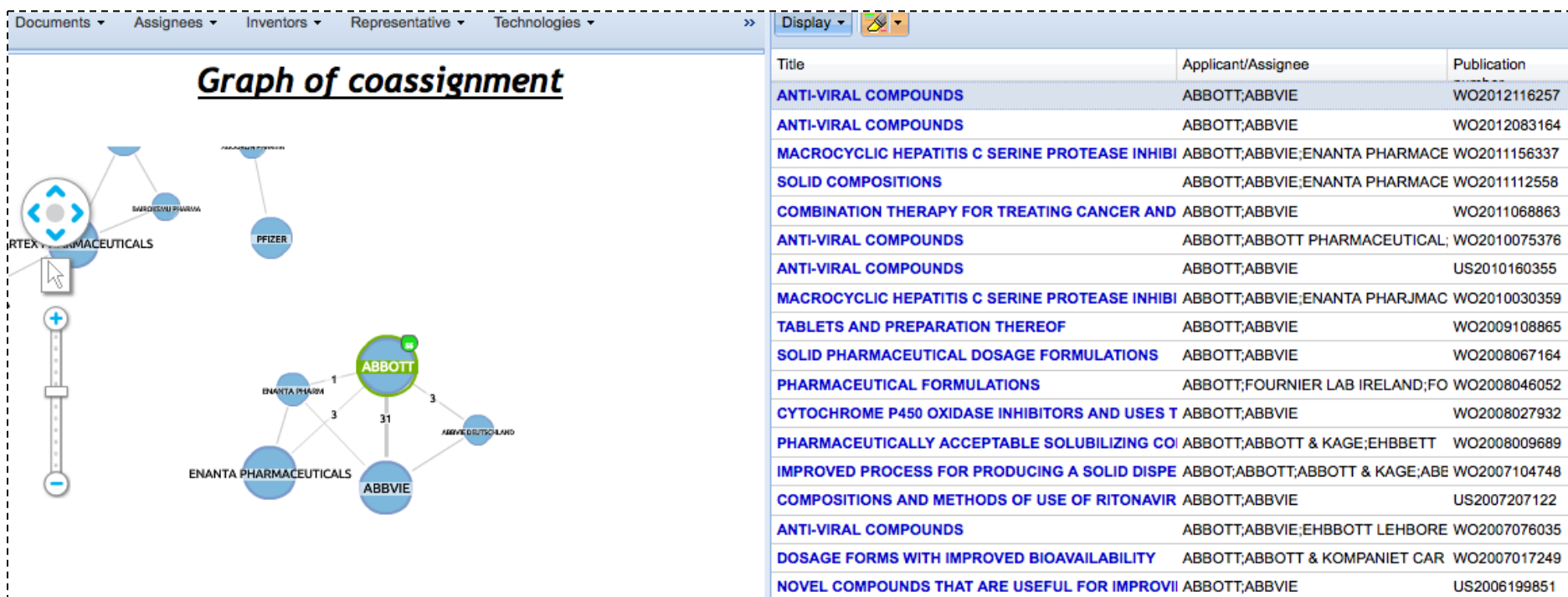
Assignee name variations (> cleanup)



Ritonavir co-assignments



Abbot-Enanta co-assignments





Citation analysis

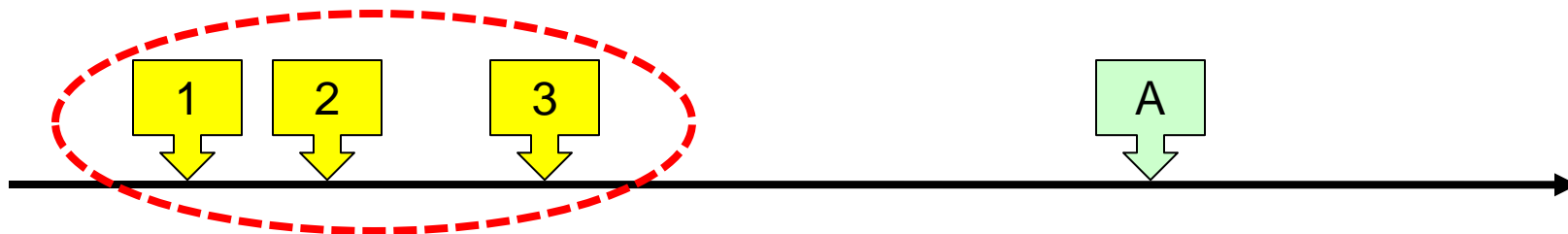
- Patent examination compares the invention with prior art
 - non-patent literature
 - other patents describing similar technologies/solutions
- Patents
 - can cite other patents as prior art (**backward citations**)
 - can be cited by other patents (**forward citations**)

Backward and forward citations

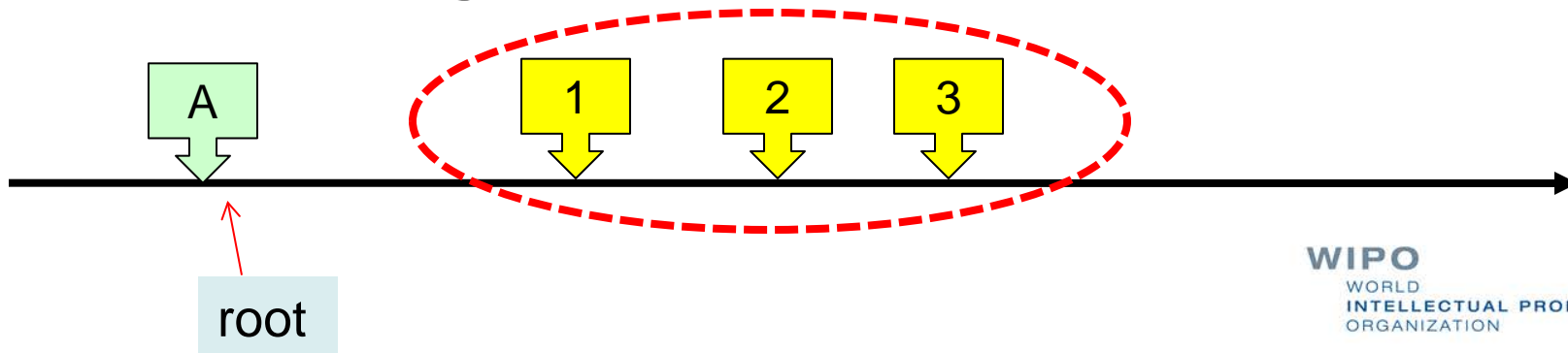
For any publication A:

Time dimension

Publications **cited** in A → Backward citations of A

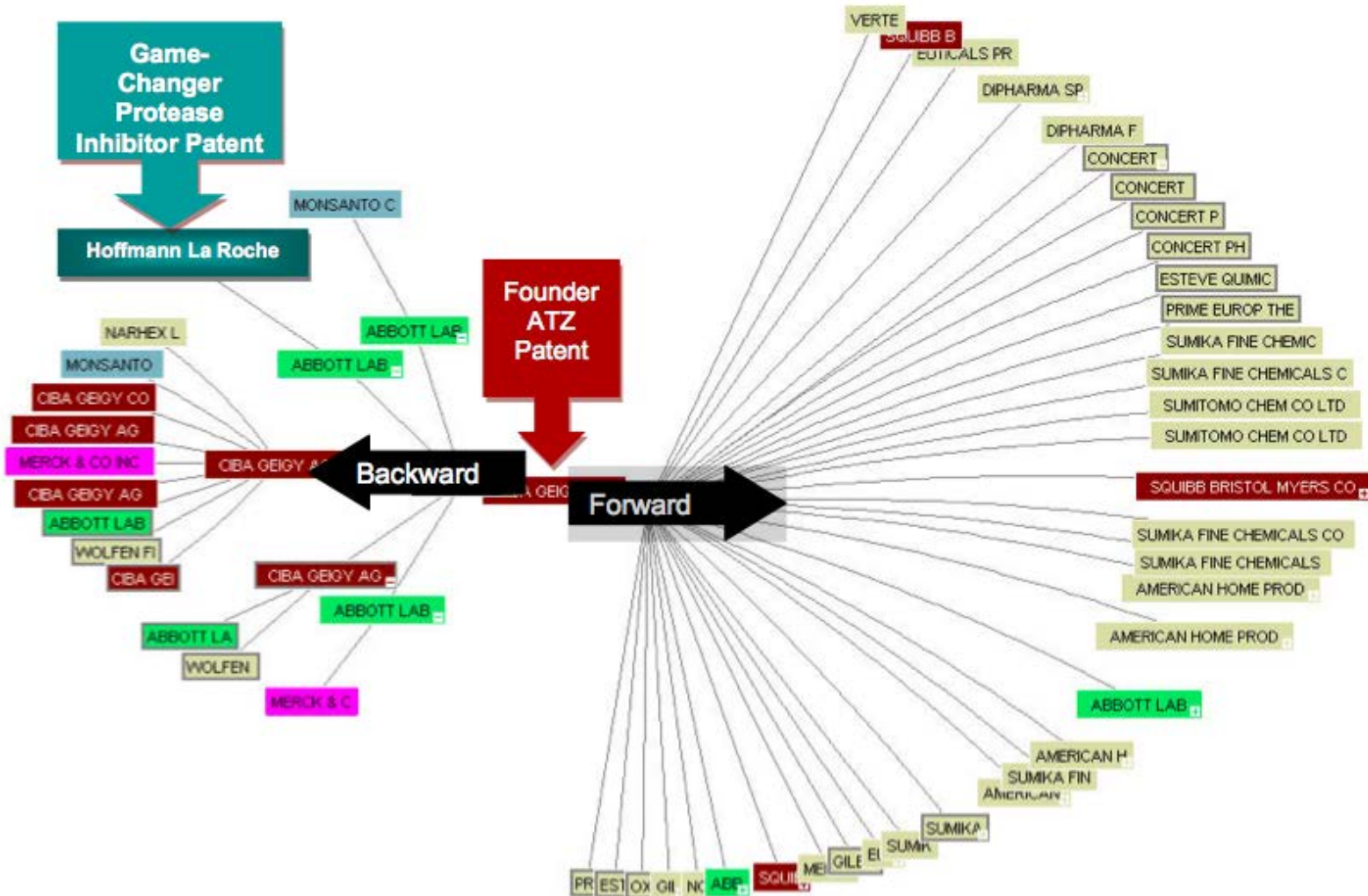


Publications **citing** A → Forward citations of A



Atazanavir – citation map

Figure 29. Citation map of the founder composition patent for Atazanavir





Citation analysis

- Citation network analysis is more complex than collaboration network analysis, because
- Citations in patent literature are more complex than in scientific literature where only the author selects citations
- Prior art can be cited by
 - Applicant (often self-citations)
 - Patent examiner(s) of different IPOs where family members are pending
 - Third parties (e.g. examination or opposition)
- Citations can change over the life cycle of an application, e.g. for different publication stages (domestic family)
 - US-A1 never include prior art, US-B1 always
 - EP-A1 always include, EP-B1 may include others, EP-B2 will so



Citation analysis

- Citations can be published or hidden in the file, e.g.
 - IPRP (chapter II) may include additional citations that are never listed in an official PCT ISA search report
 - Supplementary international search reports are not published
 - Bevor US-B1 publication, citations only accessible through US-PAIR



Citation analysis

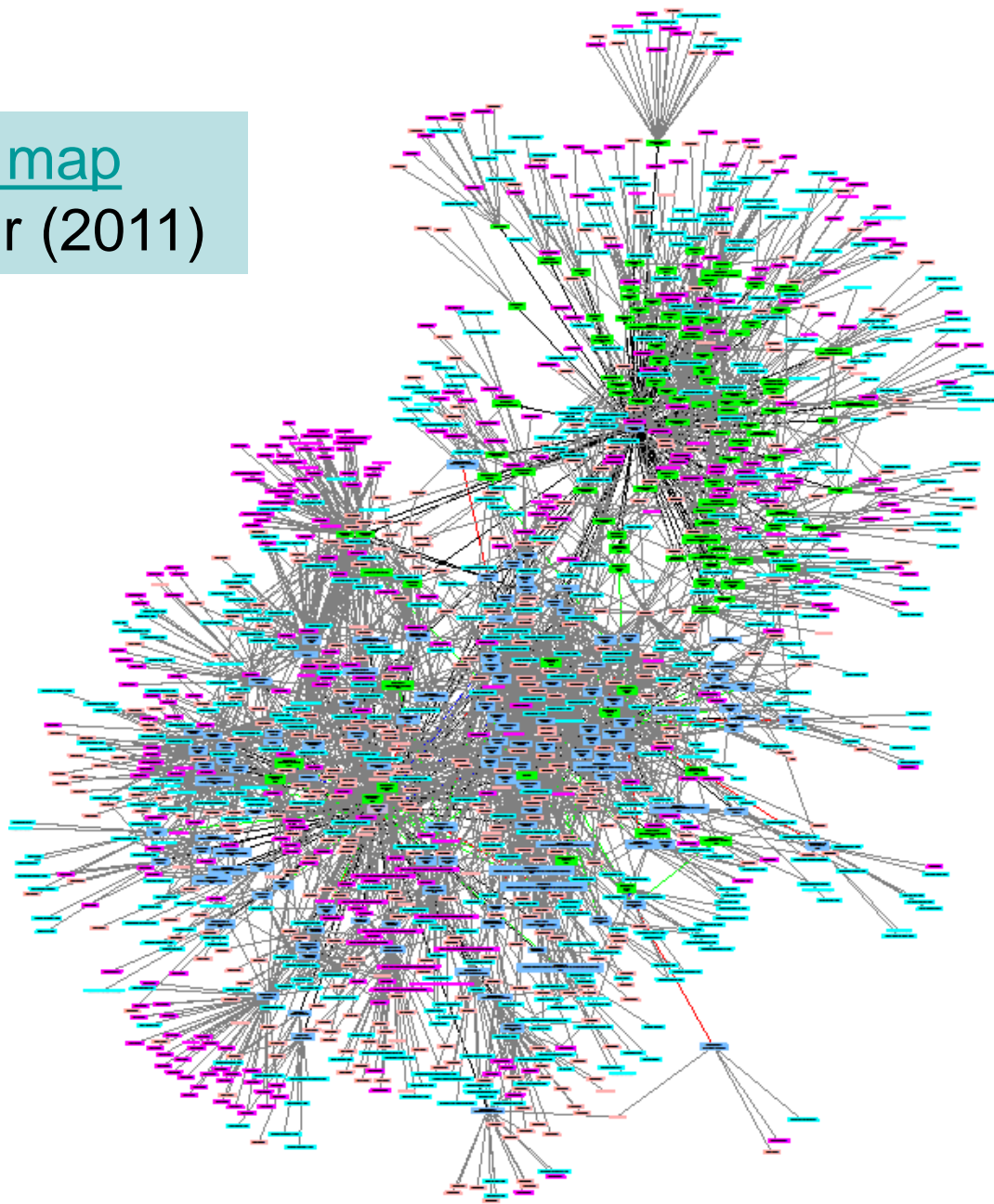
- List of prior art (search report) is edited by examiner(s)
- Citations may be categorized by the examiner(s)
 - X – relevant for novelty
 - Y – relevant for inventive step
 - A – general technical background
- Can be different for different members of a patent family (can further depend on type of family)
- Relevant if citation information is aggregated on family level



Citation analysis

- Citations indicate related or similar technology
 - Use for preparing state of the art reports
- Frequency of citations may be indicator for key inventions
 - Use for valuation of patents/portfolios
- Various commercial tools for creating citation maps (network graphs)
 - Example Ritonavir [visualization](#)

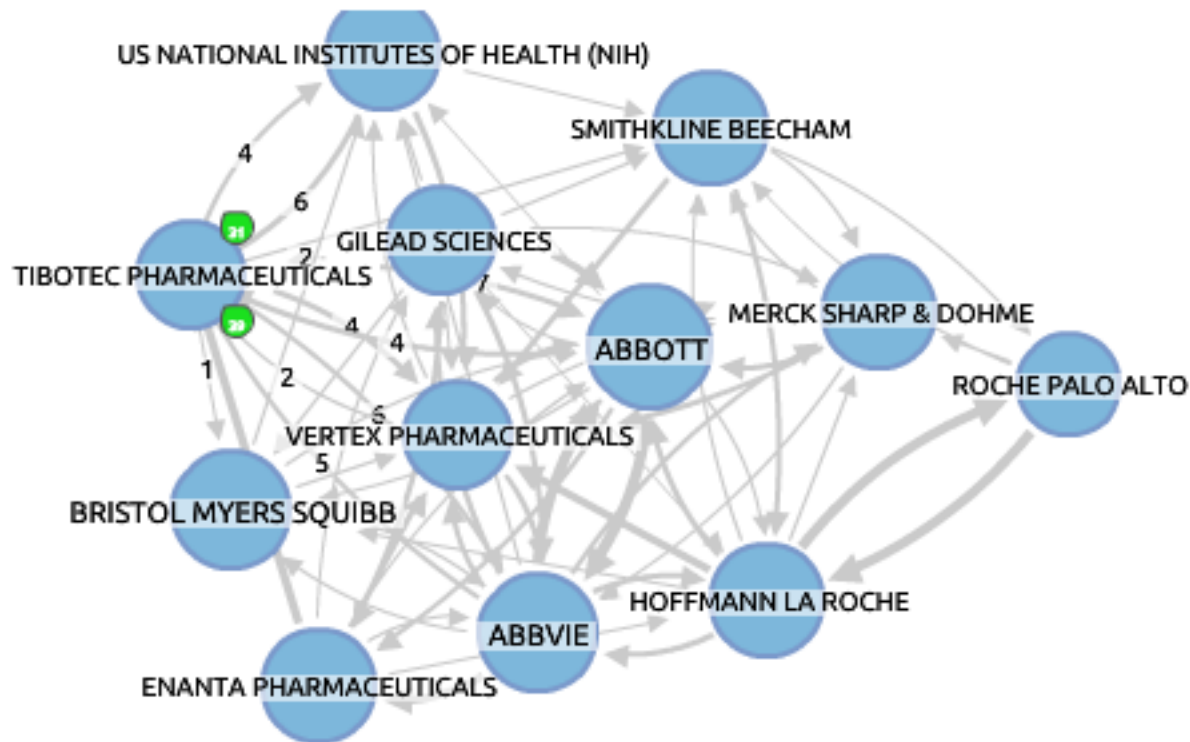
Citation map
Ritonavir (2011)



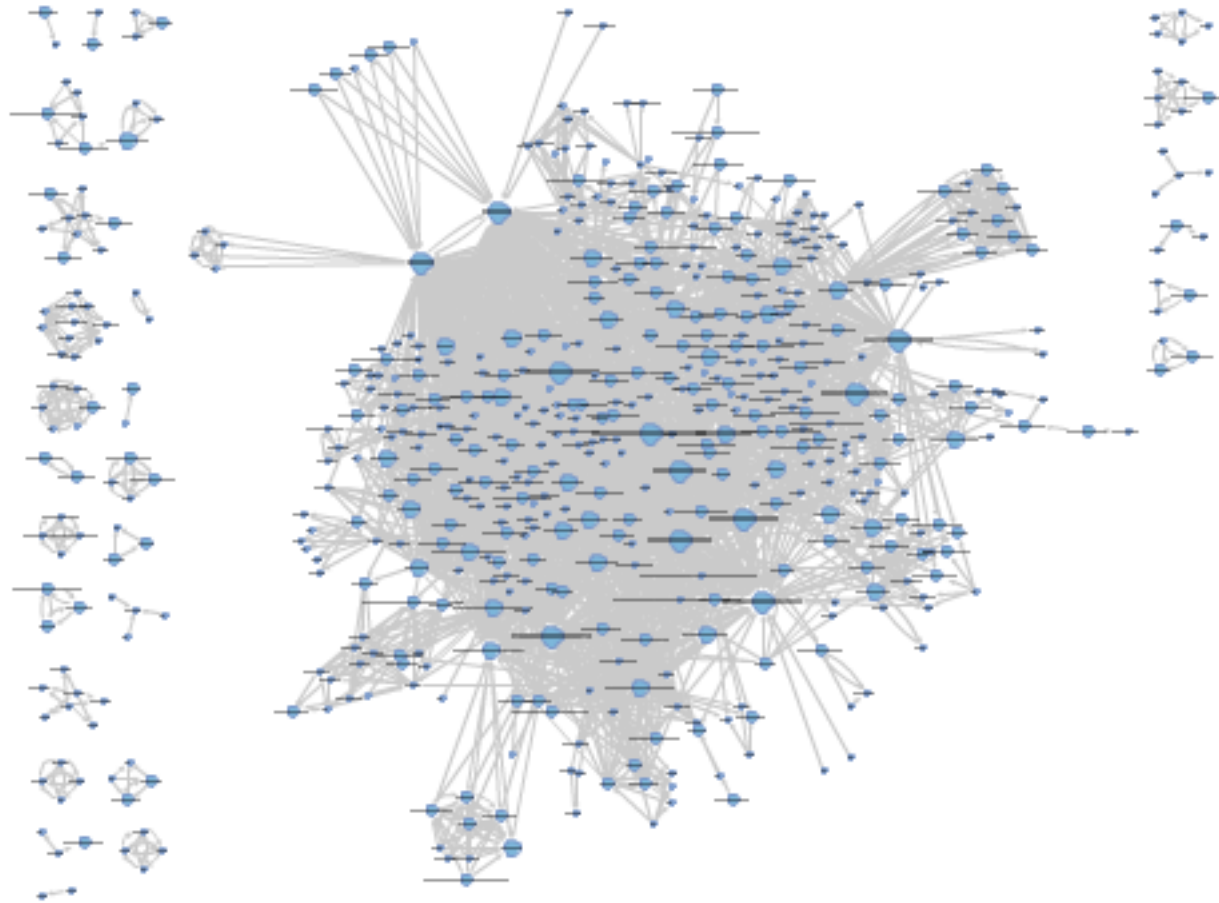
Citation maps

- Can be complex graphs
- Often simplified to tree-like graphs
 - Root document as starting point
 - Documents citing the root document
 - Documents citing these documents, etc. (“generations”, **time dimension**)
 - Citations in between such generation layers are omitted
 - Hyper(bolic) trees to cope with increasing numbers in subsequent generations

Ritonavir citations (>20 applications)

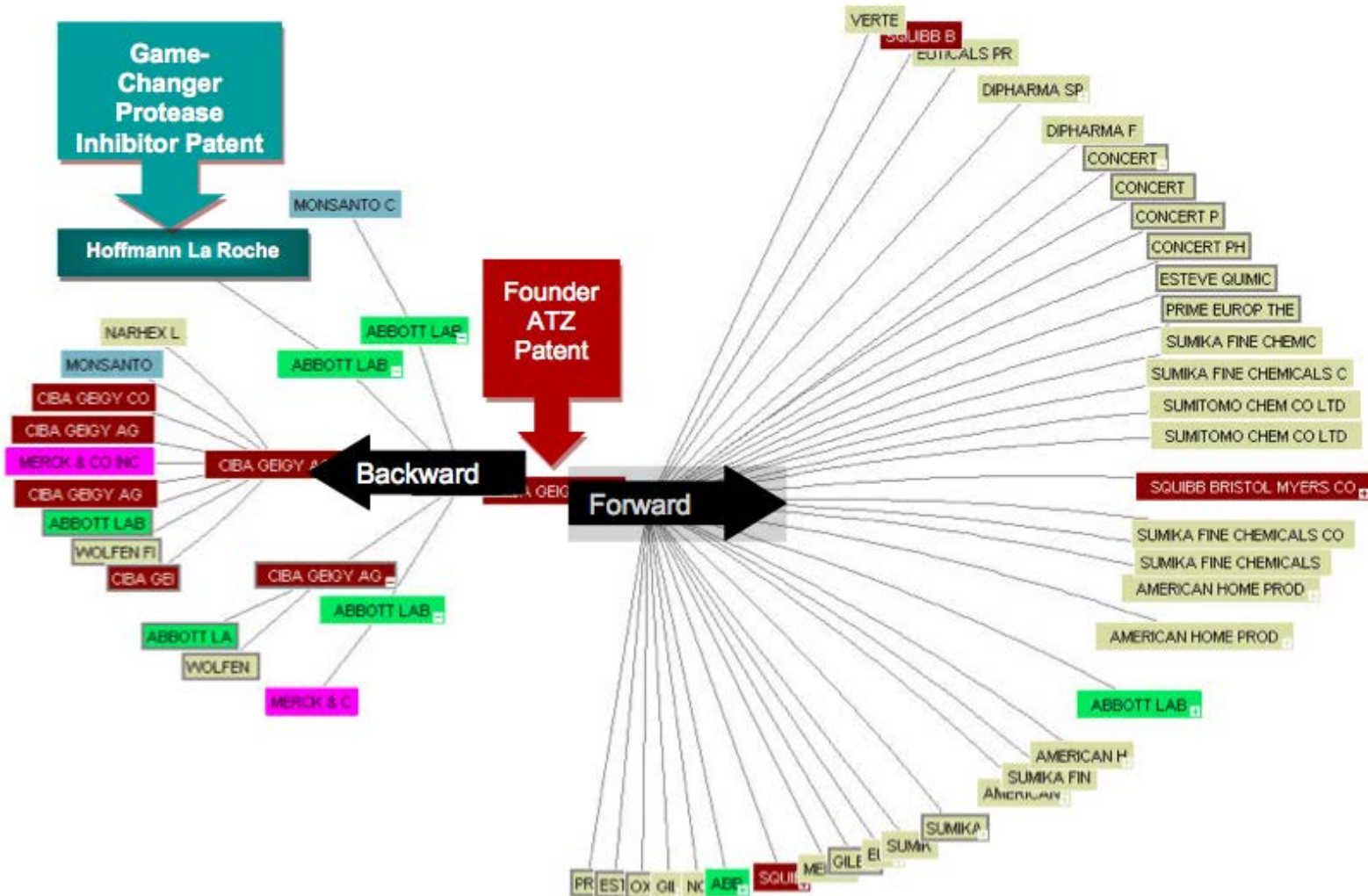


Ritonavir citations (all)



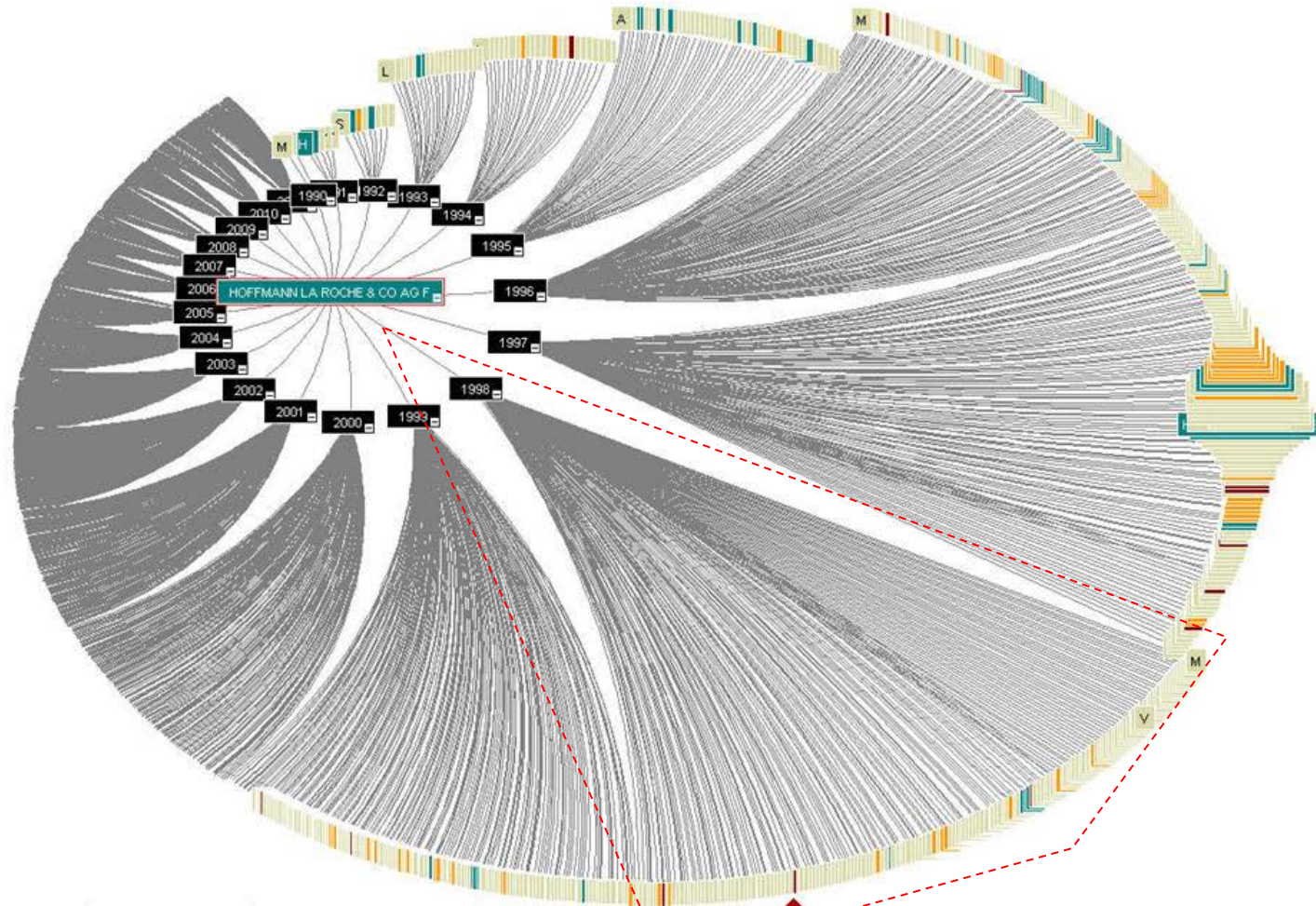
Atazanavir – citation map

Figure 29. Citation map of the founder composition patent for Atazanavir



Atazanavir – citation map

Publication Years	Citing Documents
1989	1
1990	2
1991	5
1992	8
1993	20
1994	24
1995	45
1996	120
1997	115
1998	164
1999	156
2000	187
2001	221
2002	268
2003	335
2004	255
2005	252
2006	295
2007	273
2008	288
2009	297
2010	371
2011	248
All	3950

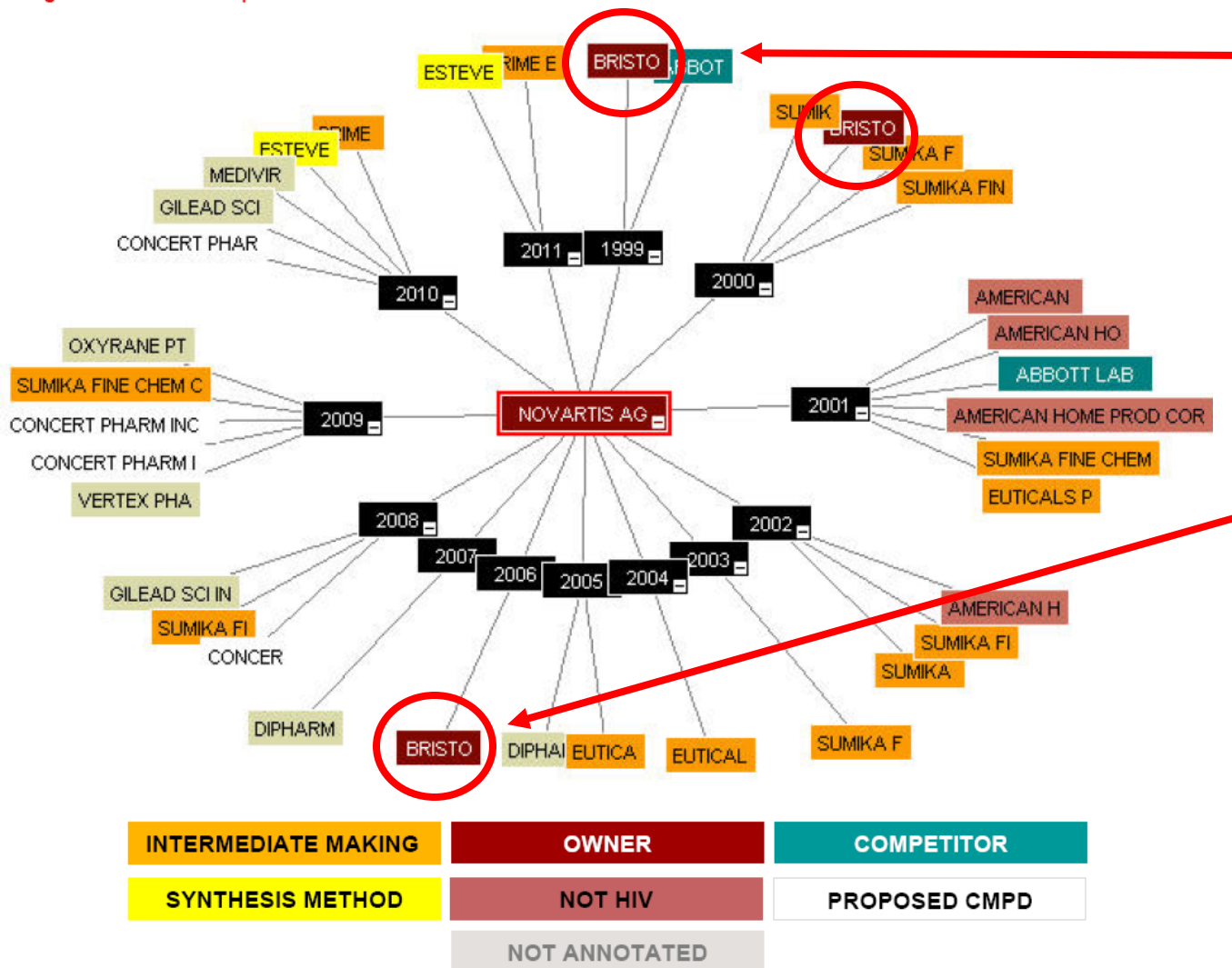


Source: Thomson Innovation™, www.thomsoninnovation.com

Atazanavir founder patent

Chemical collection – forward citation map

Figure 10. Citation Map of Founder Patent



Not all forward citations are relevant; e.g. different drug but same protease inhibitor class

Self citations indicate further innovations based on founder patent, e.g. step in innovation track



Innovation tracks

- Sometimes key inventions take place,
 - e.g. pharmaceutical substances
- Trigger series of further developments
 - e.g. combinations/formulations, synthesis,....
- Starting point of subsequent generations of related patents protecting the further innovation
- Such later patents perpetuate protection beyond the 20 years after the filing of the initial patent
- I.e. certain technologies using the initial invention may still be protected though protection of first invention may have expired

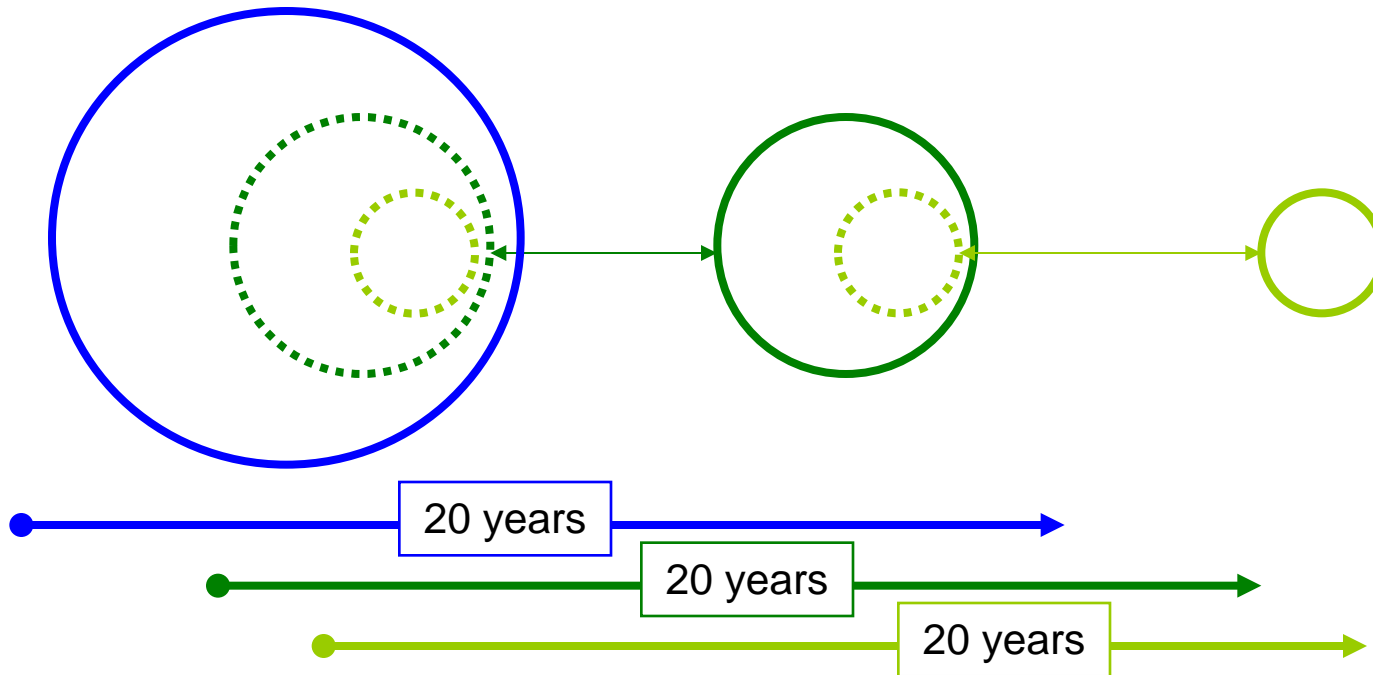
Scope of protection

1st generation

2nd generation

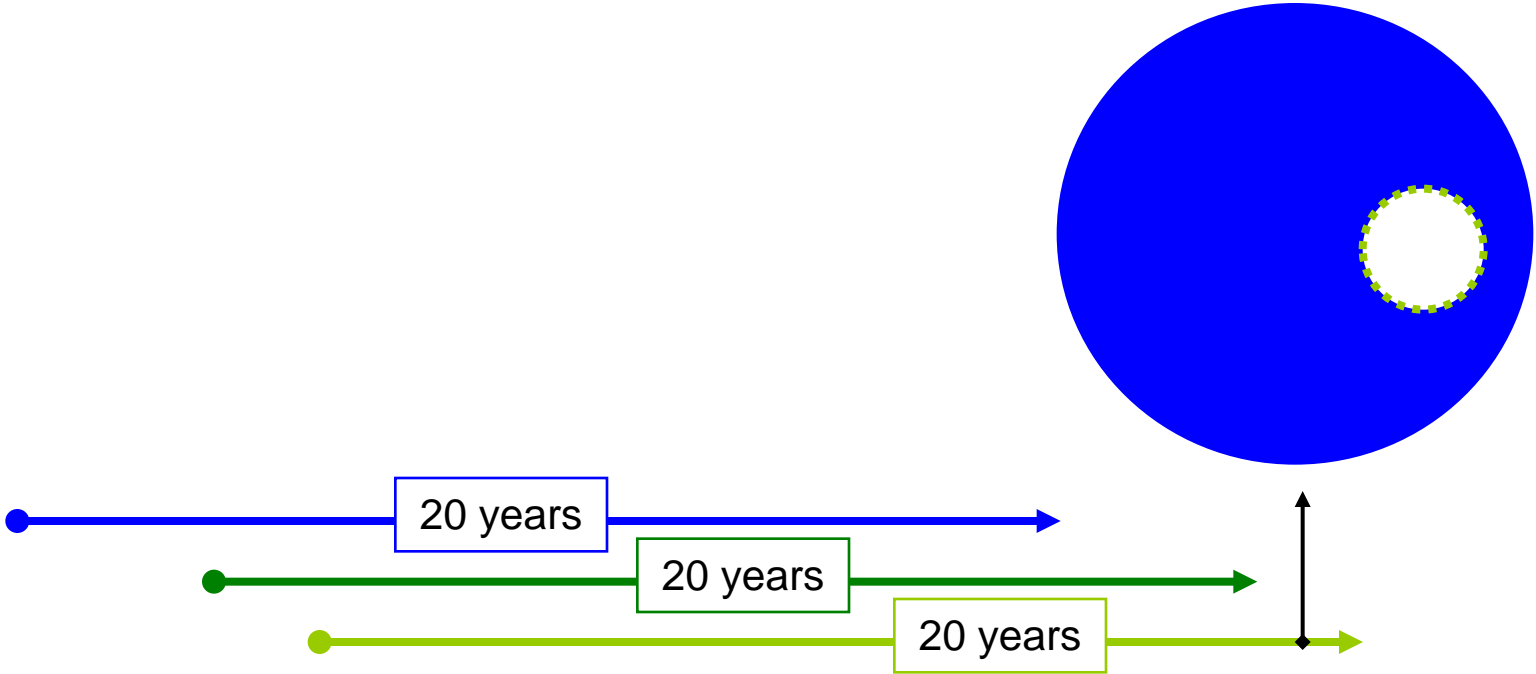
3rd generation

key patents



Duration of protection

Public domain





Identification of innovation tracks

- Categorizing of patents during retrieval stage
- Identifying most active assignees in particular category
- Reviewing documents citing the key patent
- Citation map analysis to identify "citation tracks" by exploring backward and forward citations
- Claim (granted) analysis to identify
 - overlap of claim, e.g. confirm similar scope of protection
 - New aspects of later generation (additional file inspection (via US PAIR))
- Combination of network analysis and conceptual/semantic analysis
- Result is network, should be subset of links from citation graphs

Innovation tracks liquid dosage

2nd generation
1st liquid dosage
no 3rd generation

Key patent:
Markush formula

Innovation Track 1- Liquid Oral Dosage Forms

2nd generation
Combination
Potentially liquid

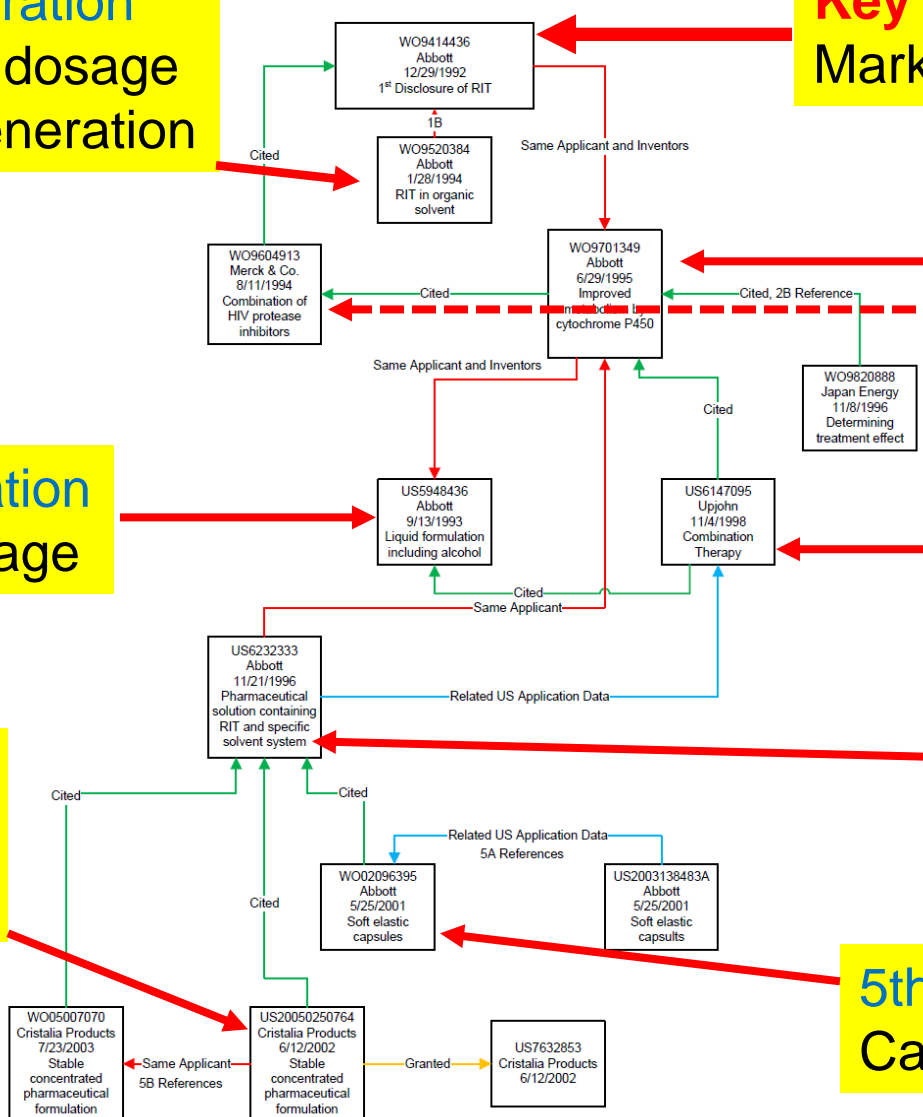
3rd generation
Liquid dosage

3d generation
Potentially liquid

5th generation
More specific
liquid dosage

4th generation
Liquid dosage

5th generation
Capsule for lq. Dos.



Sample tracks: Liquid oral dosage forms

- Liquid, gel, suspension pharmaceuticals
- Many applications in this field
- Liquid dosage was developed to cope with heat stability issues of solid dosage
- Only few selected patents establishing tracks are shown
- Later generations usually describe increasingly narrower formulations, more specific solvent systems or encapsulation formulations
- Potential for future filings

Innovation tracks explored

Innovation tracks were selected with a view to relevance for generic production in DCs

In initial report:

- Liquid oral dosage forms
- Synthesis of Ritonavir and key intermediates
- Structural considerations and polymorphs
- Solid dosage forms

Following later request from DNDI:

- Prodrugs of Ritonavir

- Recent update does not include innovation track updates

Thank you

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