Tech+IP Advisory, LLC

Creating Tangible Value From Intangible Assets ™

4G-5G SEP Landscape – Patents Declared Through Dec 31, 2021

Are Value Patterns Beginning to Emerge Globally?

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San Francisco | Sarajevo | Washington, DC | Taipei

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4G-5G SEP Update: Comments and Key Takeaways

Beyond providing an update of cellular telecommunications SEPs, we believe this "Patents Declared as of EoY 2021" report has special significance given changes in the law, markets and filing/declaration practices of SEP owners. **These changes clearly teach that: (1) SEPs are truly "global assets" and (2) more sophisticated analyses of SEP patent stacks – beyond the usual, simplistic asset counting – is needed to permit more economically rational understanding and discussion of 4G-5G SEP significance and FRAND rates. Put simply, Tech+IP posits that while all SEPs are equal, some SEPs are more equal than others. This landscape report is intended to both update the state of 4G-5G SEPs and to jumpstart a conversation about better stack analysis.**

- While 4G SEP patent counts are flattening, and precedent is adding up, 5G SEPs are accelerating as patent filings mature and, among other things, international filings turn into issued patents. It is more important than ever to carefully assess 4G data to help guide economically rational practices in a 5G (and coming 6G) world.
- Geographic data -- both on the patent side and on the market side -- is particularly important in assessing SEP patent importance, and this report goes to great lengths to begin to document such data. At the same time, we posit that other data such as the technical importance (and contribution) of certain technical specifications to which described and claimed inventions relate -- as compared to other technical specifications -- must also be assessed just as technical contribution and degree of technical difficulty is assessed in engineering and other technical domains.
- In addition, most SEP landscapes focus solely on jurisdictions where compliant products are used or sold, ignoring markets where compliant devices are made, despite the black letter law of infringement and real world licensing negotiation outcomes where royalty rates often differ based on these factors.
- Despite the large number of patents potentially necessary for any 4G-5G compliant mobile handset or network and the plethora of landscapes published by 3rd parties, however, there is almost no public discussion of:
    - what patent families are truly global (and deserving of premium FRAND rates) versus what patent families are merely regional or national (and deserving of lower FRAND rates) and how the foregoing relates to where an infringing product is made, used or sold; and
    - what assets map to which technical specifications ("TSs"), how do the TSs rank in terms of technical contribution, and whether and why that matters.

4G-5G SEP Update: Comments and Key Takeaways (Continued)

- The goal of this 4G-5G SEP report is to provide an updated set of statistics related to 4G-5G SEPs for use by the community of patent holders and implementers, and to start to delve into more sophisticated groupings and analysis of such SEPs informed both by recent court decisions and the global marketplace of licensors and licensees. The analysis proposes a method for creating family value scores (the "TIP Family Coverage Score" – see p.25 and following) that is based on real world licensing and value contexts. The methodology is applied to the 4G stack of patents because the data set is less volatile and more mature.
- In 2021, approximately 24,000 new patents and applications ("Assets") were identified to the 4G-5G standards body (ETSI) as essential to one or both of those standards. The total number of Assets declared essential to 4G-5G standards ("4G-5G SEPs") is now approximately 200,500 (at least according to their owners). At the same time, a large number (nearly 25% of all declared families) are declared for both 4G & 5G Technical Specifications.
- In 2021, ~95% of newly issued / declared Assets are related to 5G technology, strongly mirroring the evolution being seen in the market to 5G deployments. The data further shows that there are three core regions of SEPs -- the US, "Core EP" and "Core Asia" countries (see the Appendix for our definitions of these regions). However, the data also indicates that many more companies are seeking and receiving SEPs in "Fast Growth" countries like India, Brazil, Indonesia and Malaysia.
- Analyzing top company portfolios, we can identify different leaders in different segments of Assets and Families. Huawei is the leading company when analyzing overall numbers of Families that are declared to 4G-5G, whlle Qualcomm's coverage stands out when analyzing Core and Fast Growth jurisdictions. On the other hand, Samsung leads if one looks at the largest number of Families declared to both 4G & 5G Technical Specifications (TSs).
- The report that follows contains many important market-based groupings of declared 4G and 5G patents. To aid in understanding and avoid misunderstanding, a full glossary of terms used in this report are set forth in the Appendix to this document.

This report is updated quarterly and published twice a year. Tech+IP also tracks substantial additional data including data relating to financial outcomes/ comparables, royalty stack analysis and other factors relevant to economic outcomes in licensing and litigation scenarios. Please contact Tech+IP to discuss in further detail or to be added to the email list.

* Because we hope to iterative and improve this method, comments are earnestly solicited.

4G-5G Comprehensive Stack: SEP Family and Asset Counts

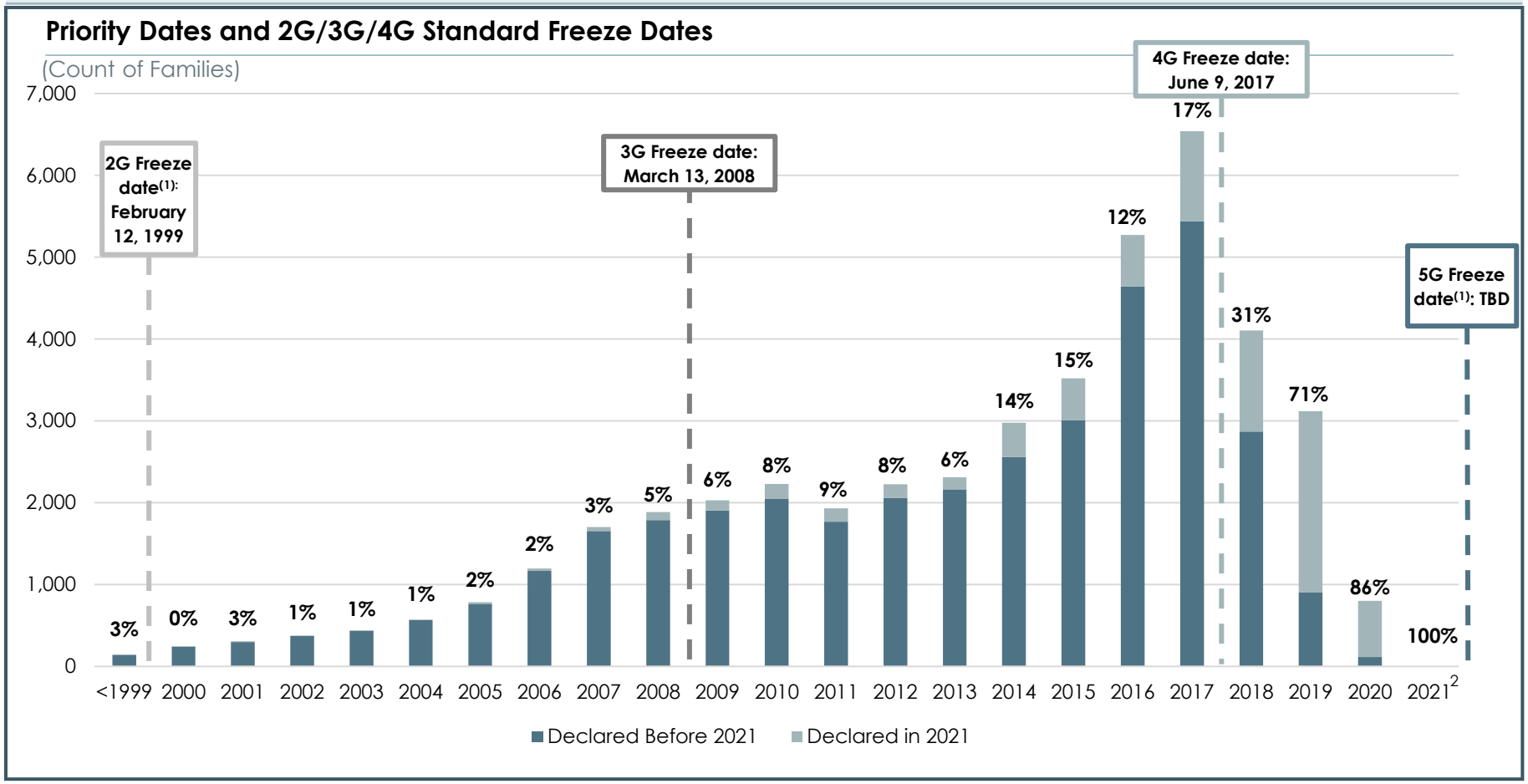
As of Jan 1, 2022, ~44,000 Patent Families, encompassing ~200,000 Assets, have been declared by their owners to be essential to 4G-5G. ~24,000 Assets were newly declared in 2021 (Jan 1, 2021 – Dec 31, 2021). While Samsung leads per number of Assets declared in 2021 with 6,000 (25% of the 2021 stack), LGE led declared Families for the first time to 4G or 5G, followed by OPPO.

#	Patent Owner	Family Breakdown		Assets Breakdown				Asset to Family Ratios		# of Declarations in 2021 Year	% of Declarations in 2021 out of Company Total
		# of Families	% of Stack	# of Assets	% of Stack	# of Granted Patents	Avg. Remaining Life	# of Assets per Family	# of Granted Patents per Family		
1	Huawei	**5,611**	**12.8%**	22,898	11.4%	17,152	11.8	4.1	3.1	477	2.1%
2	Qualcomm	4,022	9.2%	**32,834**	**16.4%**	**21,864**	9.0	8.2	5.4	1,706	5.2%
3	Samsung	3,856	8.8%	20,252	10.1%	14,312	9.8	5.3	3.7	**6,021**	29.7%
4	ZTE	3,842	8.7%	7,210	3.6%	4,357	10.6	1.9	1.1	1,072	14.9%
5	LGE	3,743	8.5%	15,684	7.8%	13,252	11.0	4.2	3.5	2,109	13.4%
6	Nokia	3,053	7.0%	11,429	5.7%	9,152	8.0	3.7	3.0	243	2.1%
7	Datang Telecom	2,899	6.6%	5,294	2.6%	3,771	12.5	1.8	1.3	690	13.0%
8	Ericsson	1,883	4.3%	11,151	5.6%	7,448	10.3	5.9	4.0	800	7.2%
9	Sharp	1,531	3.5%	5,625	2.8%	3,537	10.7	3.7	2.3	775	13.8%
10	NTT	1,393	3.2%	5,968	3.0%	3,438	9.7	4.3	2.5	414	6.9%
11	Vivo	1,360	3.1%	1,930	1.0%	773	**15.1**	1.4	0.6	1,045	54.1%
12	OPPO & OnePlus[1]	1,341	3.1%	8,197	4.1%	2,661	13.3	6.1	2.0	4,881	**59.5%**
13	Apple	996	2.3%	7,549	3.8%	6,147	10.1	7.6	6.2	226	3.0%
14	Interdigital	856	1.9%	6,603	3.3%	4,441	7.0	7.7	5.2	110	1.7%
15	Xiaomi	816	1.9%	1,494	0.7%	716	13.5	1.8	0.9		
16	ETRI	552	1.3%	1,341	0.7%	1,119	8.4	2.4	2.0	31	2.3%
17	Lenovo	529	1.2%	1,449	0.7%	656	12.4	2.7	1.2	528	36.4%
18	Sony	434	1.0%	2,785	1.4%	1,911	10.5	6.4	4.4	1,095	39.3%
19	NEC	418	1.0%	3,706	1.8%	2,933	9.6	**8.9**	**7.0**	315	8.5%
20	Alphabet	392	0.9%	1,833	0.9%	1,579	6.1	4.7	4.0	109	5.9%
21	Others	4,391	10.0%	25,422	12.7%	20,663	10.4	5.8	4.7	1,685	6.6%
	TOTAL	**43,918**	**100.0%**	**200,654**	**100.0%**	**141,882**	**9.9**	**4.6**	**3.2**	**24,332**	**12.1%**

(1) OPPO & OnePlus operate under BBK Electronics

4G-5G Comprehensive Stack: Priority Dates Breakdown

5G declarations are being filed at a faster pace than any prior generation. In 2G/3G, many Families had a priority date after the relevant technical specification freeze date. The 4g situation is quite different: most Families had a priority date before the standard's 2017 freeze date. Analysis of 2021 declarations indicates that Assets are mainly younger - 87% with priority dates between 2014-2021.



(1) See https://portal.3gpp.org/#55934-releases under Releases tab. Release 15 is considered as the first 5G related release and it was frozen on June 7, 2019, Release 16 was frozen in June 2020. Other 5G-related releases (17, 18) were delayed by COVID–related meeting restrictions and are still under development.

(2) Note that 2020 and 2021 numbers likely will substantially change in the future. Usually, a patent is published and viewable by the public after 18 months from its filing date, so many filed patent applications are not recorded yet by patent databases.

4G-5G Comprehensive Stack: Coverage of Key Geographies

Among all Families declared to 4G or 5G, the Core Global jurisdictions grouping includes the most Families, Assets and 2021 declarations. The top three Asset holders (OPPO, Samsung, & LGE) in Core Global jurisdictions declared in 2021 have 47% of all Assets. Samsung & OPPO hold 34% of 2021 newly declared Assets in Core EP jurisdictions and 61% in Fast Growth jurisdictions.

#	Patent Owner	Core Global[1]			Core EP[1]			Core Asia[1]			Fast Growth		
		# of Families	# of Assets	% of Declarations in 2021 Year	# of Families	# of Assets	% of Declarations in 2021 Year	# of Families	# of Assets	% of Declarations in 2021 Year	# of Families	# of Assets	% of Declarations in 2021 Year
1	Huawei	**5,565**	**16,927**	2.1%	**3,835**	**4,556**	1.9%	**5,227**	8,782	2.3%	1,417	1,790	0.7%
2	Qualcomm	3,867	13,308	6.6%	2,631	3,722	4.8%	3,229	**11,944**	3.9%	**2,179**	**3,886**	2.0%
3	Samsung	3,534	11,110	19.6%	2,090	2,824	17.4%	3,054	7,075	25.7%	775	1,051	15.4%
4	ZTE	3,779	5,922	14.6%	1,002	1,029	10.4%	3,699	4,357	16.1%	151	189	5.8%
5	LGE	3,534	10,531	16.9%	1,637	2,293	15.9%	2,078	5,642	9.3%	345	572	0.2%
6	Nokia	2,908	6,802	2.0%	2,061	2,281	2.3%	1,783	3,351	1.6%	725	896	0.4%
7	Datang Telecom	2,887	4,124	11.4%	632	643	3.1%	2,858	3,770	13.1%	66	66	
8	Ericsson	1,625	5,542	7.5%	1,406	1,882	8.7%	1,216	2,293	6.0%	785	1,053	1.3%
9	Sharp	1,170	3,184	10.5%	757	815	8.1%	1,294	2,344	13.1%	214	274	6.6%
10	NTT	1,126	2,967	8.2%	857	924	8.7%	1,266	2,397	7.3%	427	520	1.0%
11	Vivo	1,360	1,732	50.4%	184	188	29.8%	1,346	1,368	54.9%	7	9	11.1%
12	OPPO & OnePlus	1,323	3,927	**60.3%**	809	977	**50.1%**	1,201	3,167	**67.2%**	361	409	**39.1%**
13	Apple	968	4,623	3.5%	454	1,029	5.0%	534	2,363	2.9%	115	349	0.6%
14	Interdigital	612	2,455	1.5%	392	577	1.7%	742	2,973	1.1%	219	379	0.3%
15	Xiaomi	816	1,298		185	204		782	851		39	46	
16	ETRI	377	737	2.3%	81	125	0.8%	461	664	2.6%	7	14	
17	Lenovo	356	1.026	30.3%	194	257	28.4%	236	431	23.2%	52	66	4.5%
18	Sony	416	1,797	45.1%	346	525	49.5%	355	964	38.7%	79	121	14.9%
19	NEC	371	1,864	9.8%	301	523	11.3%	374	1,540	8.2%	121	210	2.4%
20	Alphabet	373	950	7.1%	197	265	9.8%	246	624	5.4%	133	182	1.6%
21	Others	3,778	13,918	7.8%	2,085	3,409	7.6%	3,541	9,363	8.0%	831	1,393	2.3%
	TOTAL	**40,745**	**114,744**	**11.8%**	**22,136**	**29,048**	**10.0%**	**35,522**	**76,263**	**12.1%**	**9,048**	**13,475**	**3.9%**

(1) Core Global, Core EP, Core Asia and Fast Growth definitions in Appendix

4G-5G Comprehensive Stack: Family Declarations by Key Geographies

Three distinct groupings of geographical regions show that some 4G - 5G Families are more important than others. Qualcomm declared 31% of its Families across all key geographical groupings (the US, Core EP, Core Asia, Fast Growth, and RoW countries), whereas Huawei accounts for only 9.5% of such Families. Ericsson has now reached 35% of declared Families in the US, Core EP, Core Asia, and Fast Growth regions. But Huawei has a leading 3,447 Families (61%) when assessing just three key regions (US, Core EP, and Core Asia) and Sony has been rapidly increasing its coverage in these same three regions.

#	Patent Owner	US + Core EP + Core Asia + Fast Growth + Row		US + Core EP + Core Asia + Fast Growth		US + Core EP + Core Asia		Total Families
		# of Families	% of All Families	# of Families	% of All Families	# of Families	% of All Families	
1	Huawei	534	9.5%	1,264	22.5%	**3,447**	61.4%	**5,611**
2	Qualcomm	**1,234**	**30.7%**	**1,867**	**46.4%**	2,585	64.3%	4,022
3	Samsung	329	8.5%	616	16.0%	1,901	49.3%	3,856
4	ZTE	90	2.3%	113	2.9%	755	19.7%	3,842
5	LGE	161	4.3%	264	7.1%	1,503	40.2%	3,743
6	Nokia	371	12.2%	556	18.2%	1,790	58.6%	3,053
7	Datang Telecom	10	0.3%	46	1.6%	529	18.2%	2,899
8	Ericsson	495	26.3%	662	35.2%	1,230	65.3%	1,883
9	Sharp	110	7.2%	175	11.4%	693	45.3%	1,531
10	NTT	215	15.4%	275	19.7%	714	51.3%	1,393
11	Vivo	5	0.4%	6	0.4%	154	11.3%	1,360
12	OPPO & OnePlus	321	23.9%	347	25.9%	774	57.7%	1,341
13	Apple	48	4.8%	75	7.5%	328	32.9%	996
14	Interdigital	113	13.2%	125	14.6%	355	41.5%	856
15	Xiaomi	26	3.2%	36	4.4%	159	19.5%	816
16	ETRI	4	0.7%	4	0.7%	71	12.9%	552
17	Lenovo	6	1.1%	41	7.8%	176	33.3%	529
18	Sony	53	12.2%	71	16.4%	329	**75.8%**	434
19	NEC	77	18.4%	106	25.4%	276	66.0%	418
20	Alphabet	67	17.1%	81	20.7%	176	44.9%	392
21	Others	498	11.3%	647	14.7%	1,951	44.4%	4,397
	TOTAL	**4,767**	**10.9%**	**7,377**	**16.8%**	**19,896**	**45.3%**	**43,924**

4G-5G Comprehensive Stack: Assets With TSs Declared to Both 4G & 5G

Tech+IP took a separate look at Assets and Families declared to **both** 4G and 5G related TSs. Qualcomm leads with the most Assets declared to both 4G & 5G Technical Specifications (TSs) followed by Samsung, LGE, Huawei, and Ericsson. These five declarants out of 115 total declarants (with at least one such Family) hold 60% of these Assets. Samsung leads in Families (17% of total), followed by Huawei (14%), and Qualcomm (11%). Interestingly, Blackberry has the best ratio (61%) of Families declared to both 4G & 5G to its total number of 4G-5G Families.

#	Patent Owner	Asset Breakdown				Family Breakdown			
		# of Assets Declared to Both 4G & 5G	% of Stack	% of Assets Declared to Both 4G & 5G out of Company Total 4G & 5G Stack	# of Declarations in 2021 to Both 4G & 5G	# of Families Declared to Both 4G & 5G	% of Stack	% of Families Declared to Both 4G & 5G out of Company Total 4G & 5G Stack	# of Families Declared in 2021 to Both 4G & 5G
1	Samsung	9,856	14.9%	48.7%	**320**	**1,842**	**16.5%**	47.8%	**120**
2	Huawei	5,707	8.6%	24.9%	68	1,540	13.8%	27.4%	33
3	Qualcomm	**11,733**	**17.7%**	35.7%	130	1,203	10.8%	29.9%	49
4	LGE	7,545	11.4%	48.1%	121	884	7.9%	23.6%	59
5	Nokia	3,691	5.6%	32.3%	26	877	7.9%	28.7%	16
6	ZTE	2,057	3.1%	28.5%	234	863	7.7%	22.5%	156
7	Sharp	3,028	4.6%	53.8%	38	654	5.9%	42.7%	14
8	Ericsson	4,965	7.5%	44.5%	25	602	5.4%	32.0%	5
9	NTT	1,924	2.9%	32.2%	57	397	3.6%	28.5%	21
10	Oppo & OnePlus	988	1.5%	12.1%	312	282	2.5%	21.0%	71
11	Interdigital	3,236	4.9%	49.0%	7	279	2.5%	32.6%	6
12	Datang Telecom	459	0.7%	8.7%	114	250	2.2%	8.6%	79
13	NEC	1,451	2.2%	39.2%	128	170	1.5%	40.7%	39
14	Blackberry	1,147	1.7%	**54.9%**	10	136	1.2%	**61.3%**	1
15	Apple	3,260	4.9%	43.2%	23	118	1.1%	11.8%	9
16	ETRI	502	0.8%	37.4%	6	115	1.0%	20.8%	5
17	Alphabet	433	0.7%	23.6%	18	105	0.9%	26.8%	11
18	Mediatek	542	0.8%	33.9%	3	103	0.9%	34.3%	3
19	Sony	641	1.0%	23.0%	226	100	0.9%	23.0%	56
20	Fujitsu	359	0.5%	21.8%	20	67	0.6%	18.8%	4
21	Others	2,762	4.2%	11.1%	107	573	5.1%	9.2%	57
	TOTAL	**66,286**	**100.0%**	**33.0%**	**1,993**	**11,160**	**100.0%**	**25.4%**	**814**

5G Stack: SEP Family and Asset Counts

The 5G stack analyzed on its own comprises ~35,500 Families and ~156,500 Assets worldwide. Approximately 75% of 5G Families are declared to the TS 38 series of specifications, which was/is the initial series of the 5G standard. LG, with 7,718 assets leads in Families declared, followed by OPPO (962). Together the 2 assignees have 27% of all Families declared in 2021.

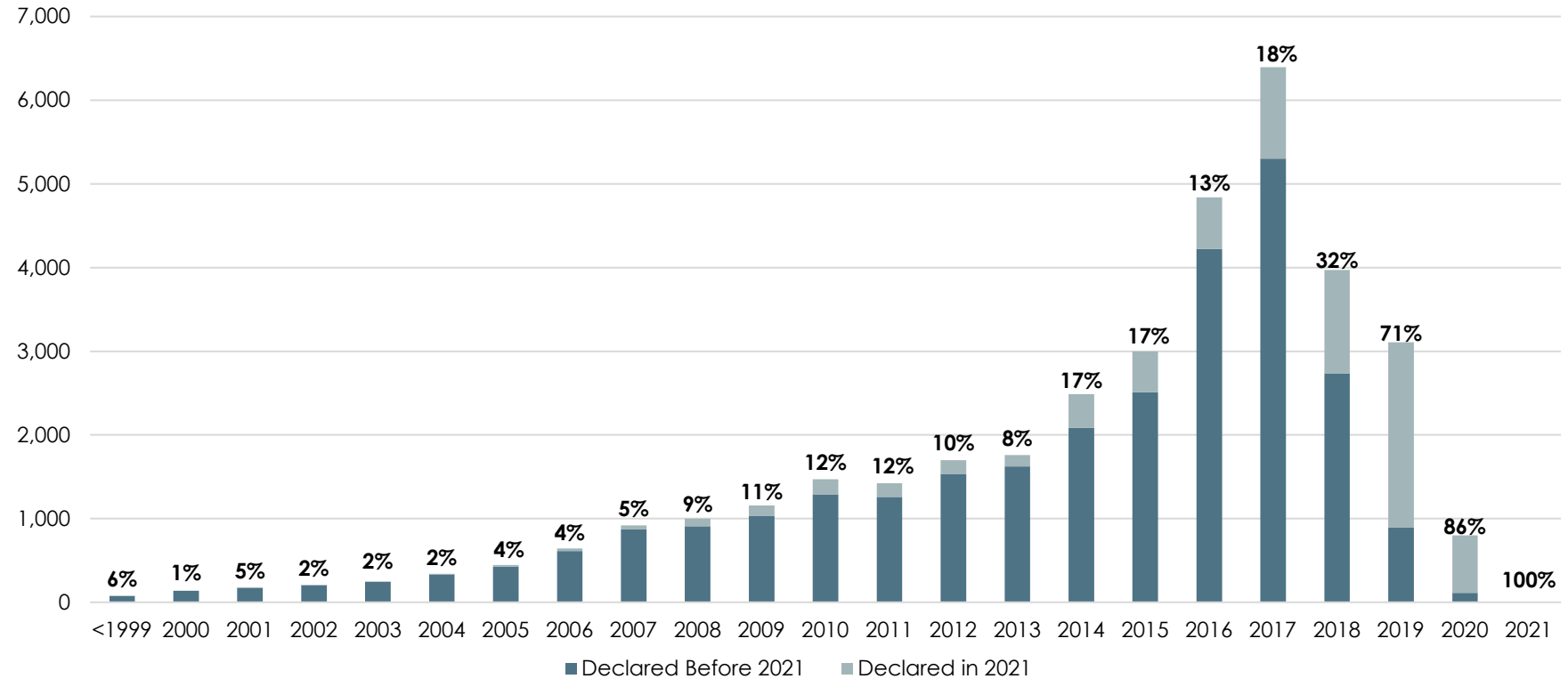
#	Patent Owner	Family Breakdown				Assets Breakdown				Asset to Family Ratios		# of Declarations in 2021 Year	% of Declarations in 2021 out of Total
		# of Families	% of Stack	# of (TS 38)	% of Stack (TS 38)	# of Assets	% of Stack	# of Granted Patents	Avg. Remaining Life	# of Assets per Family	# of Granted Patents per Family		
1	Huawei	**4,604**	**13.0%**	**3,667**	**13.8%**	19,223	12.3%	13,989	12.3	4.2	3.0	461	2.4%
2	Samsung	3,677	10.3%	3,211	12.0%	19,761	12.6%	13,857	9.9	5.4	3.8	**6,021**	30.5%
3	ZTE	3,585	10.1%	2,532	9.5%	6,777	4.3%	3,968	10.7	1.9	1.1	1,072	15.8%
4	Qualcomm	3,326	9.4%	2,791	10.5%	**25,684**	**16.4%**	**16,335**	9.4	7.7	4.9	1,685	6.6%
5	LGE	3,176	8.9%	2,661	10.0%	13,415	8.6%	11,195	11.5	4.2	3.5	2,109	15.7%
6	Nokia	2,816	7.9%	1,414	5.3%	10,384	6.6%	8,252	8.2	3.7	2.9	241	2.3%
7	Datang Telecom	2,033	5.7%	1,479	5.5%	3,555	2.3%	2,125	14.5	1.7	1.0	687	19.3%
8	Ericsson	1,535	4.3%	1,198	4.5%	8,937	5.7%	5,808	10.5	5.8	3.8	766	8.6%
9	Sharp	1,469	4.1%	1,182	4.4%	5,437	3.5%	3,420	10.8	3.7	2.3	772	14.2%
10	Vivo	1,358	3.8%	1,097	4.1%	1,920	1.2%	766	**15.1**	1.4	0.6	1,045	54.4%
11	NTT	1,355	3.8%	658	2.5%	5,856	3.7%	3,371	9.7	4.3	2.5	414	7.1%
12	OPPO & OnePlus	1,302	3.7%	1,079	4.0%	7,832	5.0%	2,386	13.9	6.0	1.8	4,881	**62.3%**
13	Apple	628	1.8%	426	1.6%	5,095	3.3%	3,965	11.5	8.1	6.3	203	4.0%
14	Xiaomi	600	1.7%	391	1.5%	1,073	0.7%	493	14.1	1.8	0.8		
15	Interdigital	497	1.4%	343	1.3%	4,563	2.9%	3,214	7.0	9.2	6.5	110	2.4%
16	Lenovo	488	1.4%	350	1.3%	1,265	0.8%	527	13.2	2.6	1.1	511	40.4%
17	Sony	289	0.8%	186	0.7%	1,799	1.1%	1,121	10.8	6.2	3.9	934	51.9%
18	Mediatek	288	0.8%	254	1.0%	1,560	1.0%	1,110	13.4	5.4	3.9	338	21.7%
19	NEC	245	0.7%	109	0.4%	2,296	1.5%	1,751	9.9	**9.4**	**7.1**	259	11.3%
20	ETRI	225	0.6%	197	0.7%	782	0.5%	582	9.0	3.5	2.6	31	4.0%
21	Others	2,035	5.7%	1,425	5.3%	9,398	6.0%	7,022	11.2	4.6	3.5	1,374	14.6%
	TOTAL	**35,531**	**100.0%**	**26,650**	**100.0%**	**156,612**	**100.0%**	**105,257**	**10.5**	**4.4**	**3.0**	**23,914**	**15.3%**

5G Stack: Priority Dates Breakdown

82% of 5G Families in 2021 have priority dates between 2015 and 2021. Not surprisingly, the largest number of declarations in 2021 claim a 2019 priority (29% of total). Considering the large number is assets filed in 2020 and 2021 but not yet published, it is clear that the situation will likely change in the future.

Priority Dates

(Count of Families)



5G Stack: Coverage of Key Geographic Regions

Of Company declarants, Huawei leads in total Family counts across all key geographic regions (Core Global, Core EP, and Core Asia) except Fast Growth regions. Samsung has the most declarations in 2021 (18% of all Assets) declared in Core EP jurisdictions (2,796). In Core Asia jurisdictions OPPO leads in regard to Assets declared in 2021 (2,129), followed by Samsung (1,818) and Vivo (751). Fast Growth "2021" analysis shows that again Samsung and Oppo have the leading positions, holding 162 and 160 Assets, respectively.

#	Patent Owner	Core Global			Core EP			Core Asia			Fast Growth		
		# of Families	# of Assets	% of Declarations in 2021 Year	# of Families	# of Assets	% of Declarations in 2021 Year	# of Families	# of Assets	% of Declarations in 2021 Year	# of Families	# of Assets	% of Declarations in 2021 Year
1	Huawei	**4,569**	**14,327**	2.4%	**3,330**	**3,900**	2.1%	**4,270**	7,224	2.7%	1,201	1,499	0.9%
2	Qualcomm	3,259	10,937	7.9%	2,143	3,019	5.8%	2,628	**9,260**	4.9%	**1,625**	**2,928**	2.6%
3	Samsung	3,385	10,819	20.2%	2,016	2,735	18.0%	2,926	6,879	26.4%	742	1,013	16.0%
4	ZTE	3,523	5,561	15.5%	952	979	10.9%	3,452	4,076	17.2%	140	175	6.3%
5	LGE	3,072	9,223	19.3%	1,441	2,005	18.2%	1,699	4,800	10.9%	251	439	0.2%
6	Nokia	2,701	6,268	2.2%	1,931	2,107	2.5%	1,623	3,015	1.8%	640	789	0.4%
7	Datang Telecom	2,027	2,741	17.0%	382	385	4.9%	2,011	2,639	18.7%	14	14	
8	Ericsson	1,310	4,455	9.1%	1,143	1,506	10.7%	1,006	1,864	7.2%	613	829	1.7%
9	Sharp	1,142	3,086	10.8%	734	789	8.4%	1,239	2,255	13.6%	201	259	6.9%
10	NTT	1,111	2,928	8.3%	847	911	8.8%	1,246	2,358	7.4%	400	492	1.0%
11	Vivo	1,358	1,727	50.6%	182	186	30.1%	1,345	1,367	54.9%	5	7	14.3%
12	Oppo & OnePlus	1,284	3,771	**62.8%**	786	918	53.3%	1,186	3,111	**68.4%**	353	373	**42.9%**
13	Apple	607	3,024	4.7%	303	763	6.3%	338	1,583	3.9%	46	219	0.9%
14	Interdigital	411	1,842	2.0%	300	453	2.2%	427	2,034	1.6%	122	234	0.4%
15	Xiaomi	600	953		132	138		585	638		22	24	
16	ETRI	191	470	3.6%	59	95	1.1%	212	355	4.8%	6	13	
17	Lenovo	322	906	32.8%	171	225	30.2%	204	358	26.0%	41	49	6.1%
18	Sony	287	1,179	57.9%	244	331	**63.7%**	245	638	51.9%	46	63	27.0%
19	NEC	229	1,167	12.6%	198	348	13.8%	221	963	10.8%	64	115	3.5%
20	Alphabet	122	325	20.6%	76	101	25.7%	81	195	17.4%	39	53	5.7%
21	Others	1,942	6,220	16.4%	1,006	1,528	15.8%	1,783	4,116	17.4%	345	511	6.1%
	TOTAL	**33,452**	**91,929**	**14.4%**	**18,376**	**23,422**	**11.9%**	**28,727**	**59,728**	**15.3%**	**6,916**	**10,098**	**5.2%**

5G Stack: Family Declarations Per Key Geographic Regions

When looking at 5G filing patterns it is clear that patent owners consider some jurisdictions more important than others. Qualcomm declared 29% of its Families across all geographic groupings (the US, Core EP, Core Asia, Fast Growth, and RoW countries), while ZTE declared only 2%. Qualcomm is also the declarant with the most Families in the US, Core EP, Core Asia, and Fast Growth regions, by a wide margin (25% of all Families). When looking at portfolio percentages, NEC, Sony, and Huawei hold the first three positions and have an outstanding pace of Family declarations in the mentioned regions (70%, 69%, and 65% respectively), while in overall number of families Huawei is a clear leader with more than 3,000 Families.

#	Patent Owner	US + Core EP + Core Asia + Fast Growth + Row		US + Core EP + Core Asia + Fast Growth		US + Core EP + Core Asia		Total Families
		# of Families	% of All families	# of Families	% of All families	# of Families	% of All families	
1	Huawei	445	9.7%	1,089	23.7%	**3,003**	65.2%	**4,604**
2	Samsung	320	8.7%	591	16.1%	1,641	44.6%	3,677
3	ZTE	85	2.4%	108	3.0%	685	19.1%	3,585
4	Qualcomm	**955**	**28.7%**	**1,438**	**43.2%**	2,098	63.1%	3,326
5	LGE	125	3.9%	210	6.6%	1,152	36.3%	3,176
6	Nokia	310	11.0%	466	16.5%	1,189	42.2%	2,816
7	Datang Telecom	0	0.0%	9	0.4%	292	14.4%	2,033
8	Ericsson	348	22.7%	471	30.7%	806	52.5%	1,535
9	Sharp	106	7.2%	169	11.5%	664	45.2%	1,469
10	Vivo	3	0.2%	4	0.3%	145	10.7%	1,358
11	NTT	213	15.7%	272	20.1%	694	51.2%	1,355
12	OPPO & OnePlus	310	23.8%	321	24.7%	702	53.9%	1,302
13	Apple	19	3.0%	33	5.3%	159	25.3%	628
14	Xiaomi	14	2.3%	19	3.2%	102	17.0%	600
15	Interdigital	83	16.7%	90	18.1%	264	53.1%	497
16	Lenovo	4	0.8%	35	7.2%	153	31.4%	488
17	Sony	30	10.4%	38	13.1%	199	68.9%	289
18	Mediatek	11	3.8%	49	17.0%	140	48.6%	288
19	NEC	39	15.9%	56	22.9%	171	**69.8%**	245
20	ETRI	4	1.8%	4	1.8%	50	22.2%	225
21	Others	179	8.8%	229	11.2%	767	37.6%	2,041
	TOTAL	**3,603**	**10.1%**	**5,701**	**16.0%**	**15,076**	**42.4%**	**35,537**

5G Stack: Technical Standards Per Priority Dates Breakdown

When declared SEPs are mapped to the Technical Specification to which the Assets relate, most 5G Families have been declared to the 38.3xx and 38.2xx series. Most of those 5G Families have 2012-2017 priority. The clear takeaway is that early development focused on the physical layer and then shifted the higher levels of 5G stack.

TS Number	TS Name	Priority Date					
		2006-2008	2009-2011	2012-2014	2015-2017	2018-2021	Total Assets[1]
TS 38.213	NR; Physical layer procedures for control	14%	16%	15%	15%	16%	52,435
TS 38.331	NR; Radio Resource Control (RRC); Protocol specification	14%	13%	15%	15%	17%	50,311
TS 38.214	NR; Physical layer procedures for data	10%	13%	13%	12%	12%	41,836
TS 38.211	NR; Physical channels and modulation	13%	12%	12%	12%	8%	41,649
TS 38.212	NR; Multiplexing and channel coding	10%	9%	9%	12%	8%	34,303
TS 38.321	NR; Medium Access Control (MAC) protocol specification	10%	7%	5%	7%	9%	24,332
TS 38.300	NR; NR and NG-RAN Overall description; Stage-2	7%	6%	6%	8%	5%	22,963
TS 38.322	NR; Radio Link Control (RLC) protocol specification	3%	2%	2%	3%	2%	8,540
TS 23.501	System architecture for the 5G System (5GS)	2%	2%	2%	2%	2%	6,410
TS 23.502	Procedures for the 5G System (5GS)	1%	1%	1%	1%	1%	3,627
Other 230 TSs[2]		17%	19%	19%	14%	19%	58,791
TOTAL[1]		52,282	64,266	93,923	108,674	26,052	

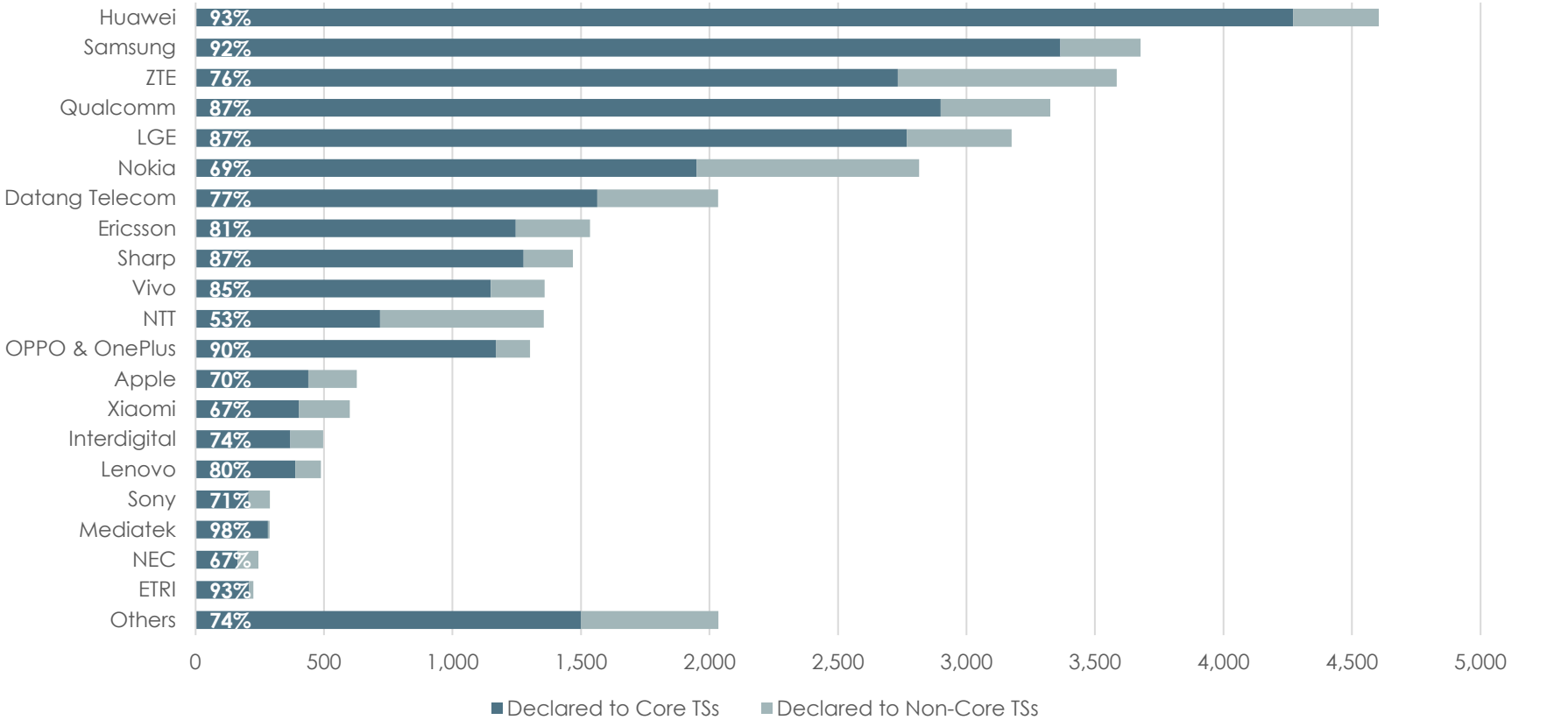
(1) There is a significant overlap in Asset counts as one Asset can be declared to multiple TSs
(2) Out of 230 other TSs related to 5G (with at least one declared Asset), there are only 62 TSs with more than 100 declared Assets.

5G Stack Declared to Core TSs: Family Counts

Given the breadth of the 5G standard and the practical reality of what "drives" licensing discussions and litigation outcomes, it seems wrong to simply treat all SEPs as equal. One way to assess this is to categorize SEPs by the TS to which they apply. The Tech+IP team believes that the technical community can define a grouping of "Core TSs" and for purposes hereof proposes that this Core TS grouping include technical specifications that define key technological features in 5G (e.g., network slicing and virtualization, Xn interface, physical channels, modulation, control and user plane separations, etc.). 38% of all 5G TSs are identified as Core 5G-related TSs (see the Appendix for a proposed full list of proposed 5G Core TSs). 82% of the total 5G Families are declared to Core TSs. The first five assignees hold 56% of all Families related to 5G Core TSs.

Company Overview

(Count of Families)



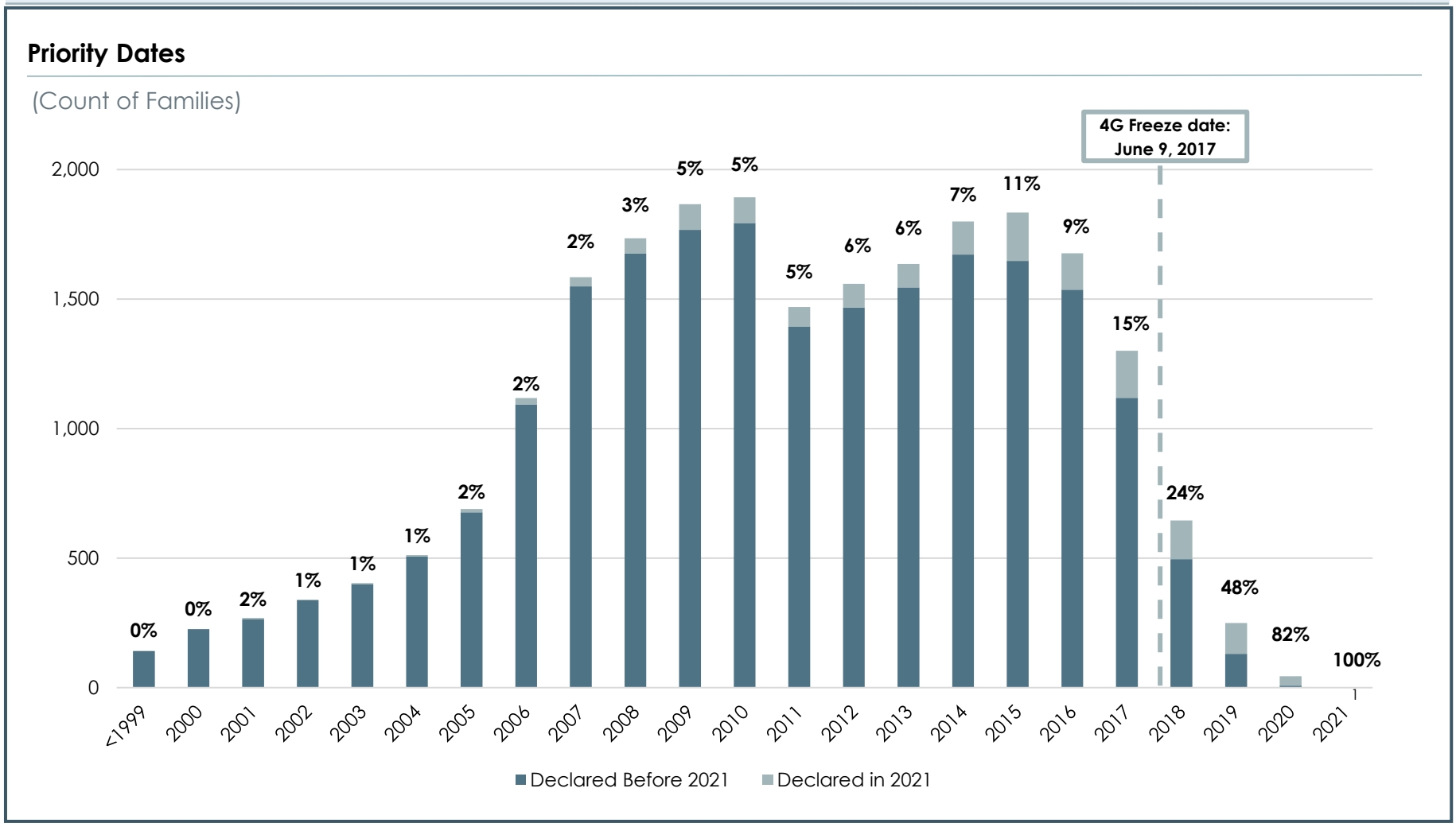
4G Stack: SEP Family and Asset Counts

The 4G stack comprises ~23,000 Families and ~138,000 Assets. Approximately 76% of all 4G Families are declared to the TS 36 series of specifications, the initial series of the 4G standard. Huawei and Qualcomm practices roughly mirror the earlier 5G discussion. Samsung leads in the number of Assets declared in 2021 (4,069) and now has more 4G declared Assets than Huawei. The top three assignees (Samsung, OPPO, and Sony) have 66% of all 4G Assets declared in 2021, while Samsung alone has almost 47% of all Assets declared in 2021.

#	Patent Owner	Family Breakdown				Assets Breakdown				Asset to Family Ratios		# of Declarations in 2021 Year	% of Declarations in 2021 out of Total
		# of Families	% of Stack	# of (TS 36)	% of Stack (TS 36)	# of Assets	% of Stack	# of Grants	Avg. Remaining Life (Grants)	# of Assets per Family	# of Grants per Family		
1	Huawei	**2,688**	**11.9%**	1,522	8.8%	12,384	9.0%	9,740	10.4	4.6	3.6	160	1.3%
2	Samsung	2,057	9.1%	**1,747**	**10.1%**	15,045	10.9%	12,631	9.3	7.3	6.1	**4,069**	27.0%
3	Qualcomm	1,986	8.8%	1,354	7.8%	**22,394**	**16.3%**	**16,731**	8.0	11.3	8.4	346	1.5%
4	ZTE	1,925	8.5%	1,496	8.7%	4,338	3.2%	3,434	10.0	2.3	1.8	540	12.4%
5	Nokia	1,673	7.4%	996	5.8%	7,690	5.6%	6,398	7.3	4.6	3.8	96	1.2%
6	LGE	1,658	7.3%	1,530	8.9%	10,878	7.9%	9,789	9.9	6.6	5.9	255	2.3%
7	Datang Telecom	1,333	5.9%	1,200	7.0%	2,748	2.0%	2,514	10.9	2.1	1.9	151	5.5%
8	Ericsson	1,014	4.5%	723	4.2%	7,942	5.8%	5,970	9.3	7.8	5.9	134	1.7%
9	NTT	787	3.5%	686	4.0%	3,959	2.9%	3,004	9.0	5.0	3.8	60	1.5%
10	Sharp	776	3.4%	681	3.9%	3,739	2.7%	2,825	10.5	4.8	3.6	113	3.0%
11	Interdigital	654	2.9%	489	2.8%	5,929	4.3%	4,232	6.8	9.1	6.5	29	0.5%
12	Apple	532	2.4%	446	2.6%	6,580	4.8%	5,613	9.6	**12.4**	**10.6**	147	2.2%
13	ETRI	444	2.0%	421	2.4%	1,145	0.8%	1,041	7.9	2.6	2.3	17	1.5%
14	OPPO & OnePlus	425	1.9%	361	2.1%	2,632	1.9%	1,284	11.2	6.2	3.0	1,055	**40.1%**
15	Alphabet	370	1.6%	312	1.8%	1,759	1.3%	1,550	6.1	4.8	4.2	48	2.7%
16	NEC	356	1.6%	240	1.4%	3,447	2.5%	2,819	9.4	9.7	7.9	226	6.6%
17	Fujitsu	336	1.5%	326	1.9%	1,565	1.1%	1,395	7.7	4.7	4.2	24	1.5%
18	Sony	317	1.4%	272	1.6%	2,258	1.6%	1,680	10.1	7.1	5.3	629	27.9%
19	Xiaomi	258	1.1%	214	1.2%	599	0.4%	348	**11.3**	2.3	1.3		
20	Kyocera	248	1.1%	241	1.4%	673	0.5%	652	**11.3**	2.7	2.6		
21	Others	2,734	12.1%	2,000	11.6%	19,995	14.5%	16,818	9.3	7.3	6.2	645	3.2%
	TOTAL	**22,571**	**100.0%**	**17,257**	**100.0%**	**137,699**	**100.0%**	**110,468**	**9.0**	**6.1**	**4.9**	**8,744**	**6.4%**

4G Stack: Priority Dates Breakdown

4G declared Families' priority dates are concentrated in 2006-2017 and 4G declarations in 2021 remain strong in those years (85% of total). Not surprisingly, less than 4% of all 4G declared Families have priority dates after the Standard's freeze date.



(1) Note that the 2020 and 2021 numbers may change in the future, for the reasons previously noted.

4G Stack: Coverage of Key Geographic Regions

Among Families declared to 4G, the Core Global grouping includes the most Families, Assets, and declarations in 2021. Huawei leads a total of 4G Family counts in geographic regions except for Fast Growth. As previously noted, Fast Growth regions should be a focus because of licensing practices and other factors. Looking only at 2021 declared Assets in Fast Growth countries, Samsung has the most declarations – 59% of the total followed by OPPO (10%) and Qualcomm (7%), while LGE, Datang Telecom, NTT, Interdigital, ETRI and Fujitsu did not declare any.

#	Patent Owner	Core Global			Core EP			Core Asia			Fast Growth		
		# of Families	# of Assets	% of Declarations in 2021 Year	# of Families	# of Assets	% of Declarations in 2021 Year	# of Families	# of Assets	% of Declarations in 2021 Year	# of Families	# of Assets	% of Declarations in 2021 Year
1	Huawei	**2,668**	**8,602**	1.4%	**1,692**	2,267	1.3%	**2,544**	4,764	1.4%	704	946	0.3%
2	Samsung	1,988	7,843	14.5%	1,331	1,983	10.4%	1,661	4,974	21.8%	666	937	17.3%
3	Qualcomm	1,847	7,824	1.8%	1,484	**2,341**	1.6%	1,761	**8,087**	1.3%	**1,459**	**2,830**	0.7%
4	ZTE	1,916	3,354	13.7%	660	684	9.8%	1,850	2,333	14.9%	139	176	4.5%
5	Nokia	1,595	4,086	1.3%	1,189	1,360	1.6%	1,096	2,312	1.1%	555	692	0.4%
6	LGE	1,539	6,829	3.0%	907	1,511	3.2%	1,214	4,097	1.5%	315	538	
7	Datang Telecom	1,325	2,158	5.7%	407	418	3.8%	1,306	1,790	6.0%	61	61	
8	Ericsson	966	3,718	1.9%	843	1,253	2.2%	712	1,544	2.1%	560	782	0.6%
9	NTT	609	1,699	2.1%	452	517	2.7%	746	1,531	1.8%	336	426	
10	Sharp	710	2,282	3.0%	558	614	3.1%	748	1,533	2.9%	164	218	3.7%
11	Interdigital	471	2,088	0.5%	285	463	0.9%	585	2,671	0.4%	202	361	
12	Apple	522	3,813	2.4%	238	809	4.3%	283	2,036	2.3%	99	332	0.3%
13	ETRI	295	627	1.9%	74	117	0.9%	357	537	1.5%	5	12	
14	OPPO & OnePlus	416	1,309	**35.7%**	262	365	28.5%	293	775	**53.5%**	106	150	**18.7%**
15	Alphabet	355	905	3.5%	184	249	5.6%	233	599	2.5%	131	180	0.6%
16	NEC	312	1,692	7.4%	250	462	8.4%	323	1,434	6.2%	116	203	2.0%
17	Fujitsu	181	720	2.2%	110	179	3.4%	282	657	1.4%	60	87	
18	Sony	299	1,389	32.2%	242	401	**36.7%**	258	773	26.3%	74	115	13.0%
19	Xiaomi	258	464		74	93		231	269		28	35	
20	Kyocera	182	358		55	73		213	315		1	1	
21	Others	2,452	10,582	3.6%	1,588	2,775	4.0%	2,147	6,681	3.4%	706	1,239	1.3%
	TOTAL	**20,906**	**72,342**	**5.5%**	**12,885**	**18,934**	**5.0%**	**18,843**	**49,712**	**5.9%**	**6,487**	**10,321**	**2.6%**

4G Stack: Family Declarations by Key Geographic Regions

As previously seen in the 4G-5G and 5G Stack analyses, it is clear again that some 4G Families are more important than others. Qualcomm declared 42% of its 4G Families across all geographic groupings (the US, Core EP, Core Asia, Fast Growth, and RoW countries) while ZTE did in only 4%. It is important to keep in mind, however, that Qualcomm and ZTE are ranked 3rd and 4th based on the total per number of declared 4G Families. At 24%, Qualcomm leads when looking at the US, Core EP, Core Asia, and Fast Growth regions, followed by Huawei (12%) and Samsung (10%). Sharp, despite being in the middle of the pack when counting total Families, surpasses Datang Telecom and ZTE per Family declarations when the data is filtered for focus on the US, Core EP, and Core Asia regions.

#	Patent Owner	US + Core EP + Core Asia + Fast Growth + Row		US + Core EP + Core Asia + Fast Growth		US + Core EP + Core Asia		Total Families
		# of Families	% of All Families	# of Families	% of All Families	# of Families	% of All Families	
1	Huawei	332	12.4%	603	22.4%	**1,455**	54.1%	**2,688**
2	Samsung	316	15.4%	526	25.6%	1,118	54.4%	2,057
3	Qualcomm	**843**	**42.4%**	**1,226**	**61.7%**	1,450	**73.0%**	1,986
4	ZTE	84	4.4%	105	5.5%	495	25.7%	1,925
5	Nokia	310	18.5%	422	25.2%	832	49.7%	1,673
6	LGE	137	8.3%	235	14.2%	769	46.4%	1,658
7	Datang Telecom	10	0.8%	41	3.1%	350	26.3%	1,333
8	Ericsson	343	33.8%	395	39.0%	611	60.3%	1,014
9	NTT	171	21.7%	202	25.7%	392	49.8%	787
10	Sharp	84	10.8%	136	17.5%	530	68.3%	776
11	Interdigital	100	15.3%	108	16.5%	261	39.9%	654
12	Apple	43	8.1%	62	11.7%	171	32.1%	532
13	ETRI	4	0.9%	4	0.9%	61	13.7%	444
14	OPPO & OnePlus	76	17.9%	79	18.6%	198	46.6%	425
15	Alphabet	64	17.3%	77	20.8%	145	39.2%	370
16	NEC	74	20.8%	99	27.8%	223	62.6%	356
17	Fujitsu	45	13.4%	48	14.3%	101	30.1%	336
18	Sony	51	16.1%	65	20.5%	206	65.0%	317
19	Xiaomi	16	6.2%	24	9.3%	52	20.2%	258
20	Kyocera	0		0		47	19.0%	248
21	Others	436	15.9%	562	20.5%	1,347	49.2%	2,739
	TOTAL	**3,539**	**15.7%**	**5,019**	**22.2%**	**10,814**	**47.9%**	**22,576**

4G Stack: Technical Standards Per Priority Dates Breakdown

Most 4G Families have a priority year between 2007-2012. The most frequent TSs to which those Families have been declared are 36.2xx and 36.3xx.

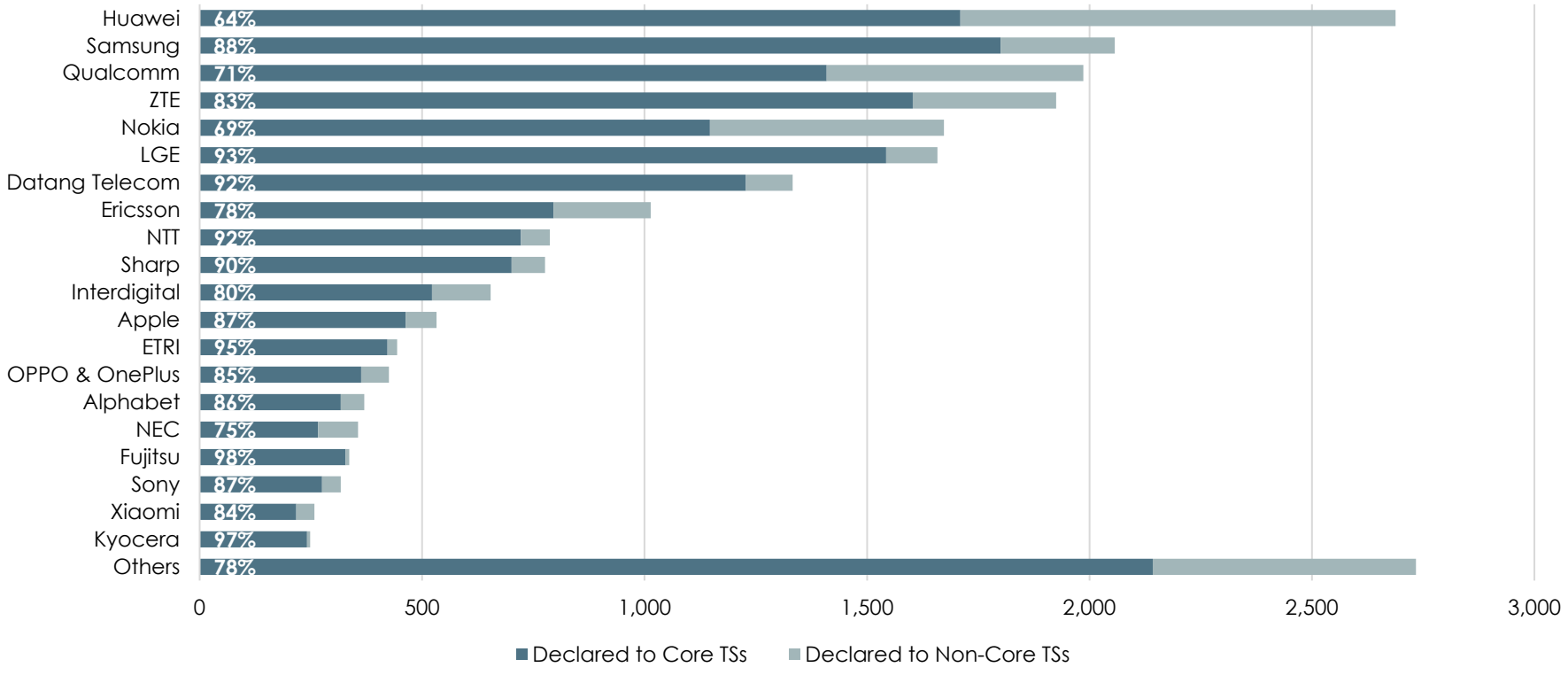
TS Number	TS Name	Priority Date				
		2004-2006	2007-2009	2010-2012	2013-2015	Total Assets[1]
TS 36.213	(E-UTRA); Physical layer procedures	16%	17%	18%	17%	56,103
TS 36.331	(E-UTRA); Radio Resource Control (RRC); Protocol specification	13%	15%	15%	16%	50,294
TS 36.211	(E-UTRA); Physical channels and modulation	16%	15%	13%	11%	46,574
TS 36.300	(E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2	13%	13%	12%	12%	42,150
TS 36.212	(E-UTRA); Multiplexing and channel coding	10%	10%	9%	8%	31,515
TS 36.321	Evolved Universal Terrestrial Radio Access (E-UTRA); Medium Access Control (MAC) protocol specification	10%	10%	9%	8%	31,480
TS 23.401	General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access	1%	2%	2%	2%	5,337
TS 26.445	Codec for Enhanced Voice Services (EVS); Detailed algorithmic description	1%	0%	1%	2%	3,416
TS 36.304	Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) procedures in idle mode	1%	1%	1%	1%	3,392
TS 36.423	Evolved Universal Terrestrial Radio Access Network (E-UTRAN); X2 Application Protocol (X2AP)	1%	1%	1%	1%	3,168
Other 412 TSs[2]		18%	15%	20%	22%	62,481
TOTAL[1]		56,678	107,596	97,053	74,583	

(1) There is a significant overlap in Asset counts as one Asset can be declared to multiple TSs
(2) Out of 412 other TSs related to 4G (with at least one declared Asset) there are 101 TSs with more than 100 declared Assets.

4G Stack Declared to Core TSs: Family Counts

Repeating our TS Core vs. Non-core categorization as previously described (see Appendix for the full list of 4G Core TSs), Tech+IP identified a group of technical specifications that define major improvements in the 4G standard (e.g., multilayer beamforming, self-organizing networks, multimedia broadcast services, home eNB, SC-FDMA in uplink, ePDCCH, eICIC, LTE and Wi-FI integration, etc.). 81% of the total 4G Families are declared to Core TSs. Out of 145 assignees that have at least one 4G Core TS Family, Samsung leads in declarations, followed by Huawei and ZTE. Together these three hold 28% of total 4G Core TS Families. Expert feedback would be appreciated.

Company Overview



4G Stack: Portfolio Family Global Value Analysis (1 of 3) - Methodology

To provide more than just the usual patent statistics related to declared 4G SEPs, the Tech+IP team took an additional step in making a unique analysis of company portfolios from the global coverage perspective on a Family level. The TIP team calculated a unique **TIP Family Coverage Score** for each declared 4G Family. For different regions/jurisdictions (as presented in the 1st table) we determined different **Net Regional Scores** used for evaluating each granted Asset in the Family (pending applications are excluded from the calculation). In making the Net Regional Scores we used a different set of coefficients related to factors such as **Regional Importance, Regional Sales, Regional Score**, and **Jurisdictional Adjustment** (see Appendix for a detailed explanation). The Net Regional Score is the sum of the Regional Score and a Jurisdictional Adjustment. Regional Score is the result of multiplying Regional Sales by Regional Importance.

The Net Regional Scores for each granted Asset in a Family were then summed to produce a **Region Coverage Score** on a Family level. If there are additional granted Assets in the below-mentioned region/jurisdiction in the same Family, the Region Coverage Score is increased by an additional add-on score as presented in the 2nd table below (i.e., **Region Coverage Score + TIP Family Coverage Score Add-on = TIP Family Coverage Score ("TIPFCS")**). The data showed a significant inflection for Families above or below 38 TIPFCS, and so we adopted that break point in our analysis. We hope to refine this in future.

The results using this method are presented on the following slides, and feedback would be much appreciated.

Calculation Factors/ Jurisdictions	US	China	Core EP	Core Asia	Fast Growth	Rest of North America	Rest of EP
Regional Importance	1.00	0.65	1.00	1.00	0.65	0.65	0.65
Regional Sales	13.0	25.4	6.8	5.0	14.5	2.9	4.0
Regional Score	13.0	16.5	6.8	5.0	9.4	1.9	2.6
Jurisdictional Adjustment	0	-2	4	1	-2	1	1
Net Regional Score	**13.0**	**14.5**	**10.8**	**6.0**	**7.4**	**2.9**	**3.6**

Number of Granted Patents in Specific Region/Jurisdiction per Family	TIP Family Coverage Score Add-on
2-4	+1
5-8	+2
9-12	+3
>12	+4

Note: If one Family contains 3 granted Assets in the US and 5 in the Core EP region, the Region Coverage Score would increase by 3 points (i.e., it would get a +1 point for the cases in the US and +2 for the cases in Core EP).

4G Stack: Portfolio Family Global Value Analysis (2/3) - Results

Using the described methodology, Tech+IP calculated the average **TIP Family Coverage Score** (presented in the table on the right side) for each of the top 20 4G patent holders based on total number of Families they hold. (This data is found in the **Simple Family Count** table on the left hand side below). The 2nd parameter calculated relates to the percentage of Families in a given company's portfolio that carry a ≥38 TIP Family Coverage Score (essentially setting as a threshold Family coverage in the US, China, and Core EP jurisdictions). Finally, the **Value Family Count** is calculated as a multiplication of Simple Family Count and the percentage of Families with 38+ TIP Family Coverage Score.

When analyzing declared patent counts in the context of Value Family Counts, we get a more comprehensive and enhanced picture of Families and portfolios with a clear value from a global perspective than achievable merely by analyzing Simple Family Counts. As expected, this provides some degree of value and not just numerical separation and portfolio comparison. The following slide presents this data graphically.

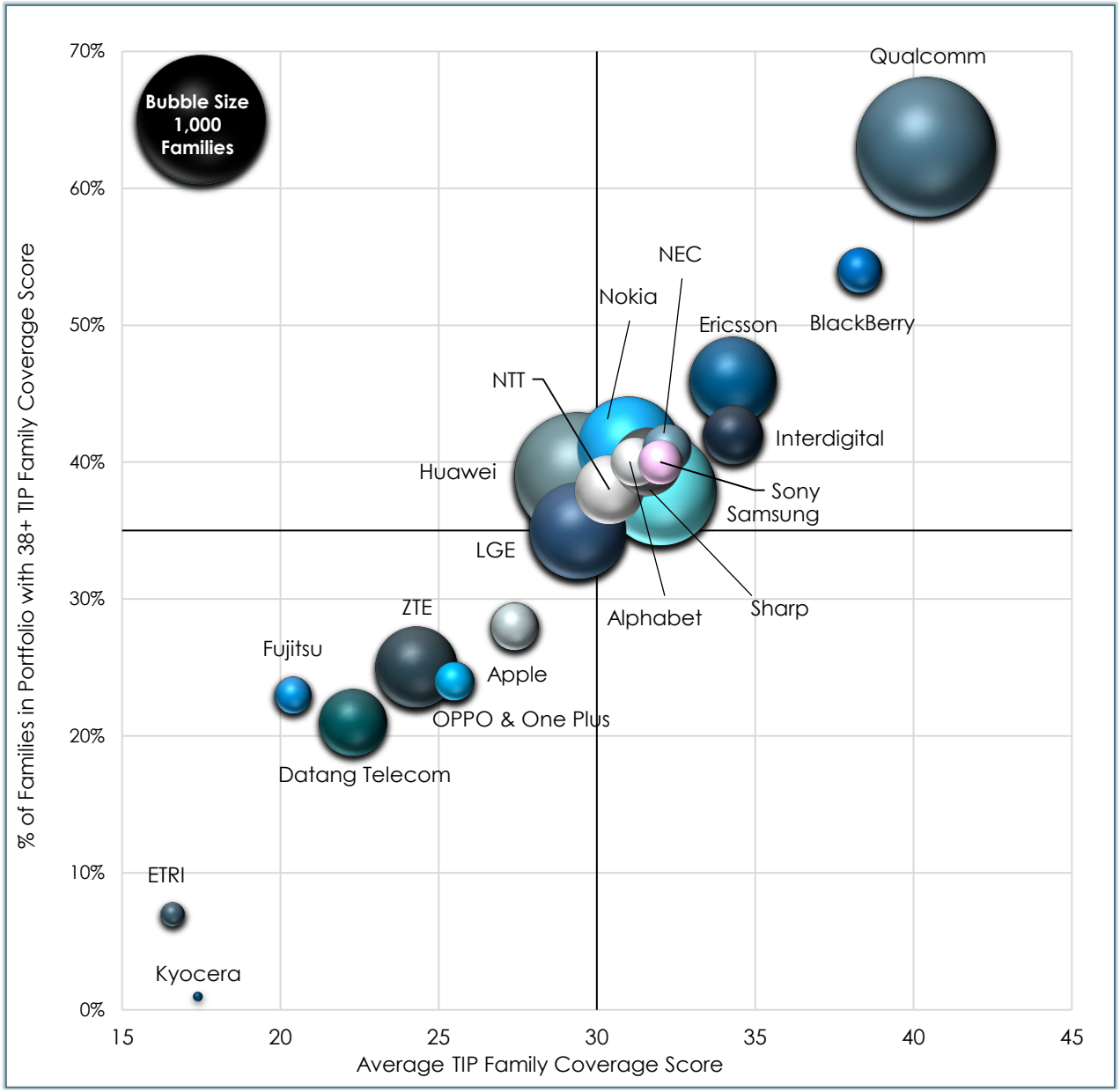
Simple Family Count – Company Level

#	Company	Total Number of Families with Granted Patents
1	Huawei	2,492
2	Samsung	1,978
3	Qualcomm	1,856
4	LGE	1,614
5	Nokia	1,587
6	ZTE	1,550
7	Datang Telecom	1,288
8	Ericsson	970
9	NTT	745
10	Sharp	717
11	Interdigital	490
12	Apple	473
13	ETRI	436
14	OPPO & One Plus	373
15	Alphabet	359
16	NEC	343
17	Fujitsu	329
18	Sony	291
19	Kyocera	242
20	BlackBerry	213

Value Family Count – Company Level (red/green arrow indicates position change)

#	Company		Average TIP Family Coverage Score	% of Families in Company Portfolio with 38+ TIP Family Coverage Score	Value Family Count
1	Qualcomm	2↑	40.4	63%	1,176
2	Huawei	1↓	29.4	39%	965
3	Samsung	1↓	32.0	38%	758
4	Nokia	1↑	31.0	41%	643
5	LGE	1↓	29.4	35%	566
6	Ericsson	2↑	34.3	46%	447
7	ZTE	1↓	24.3	25%	391
8	NTT	1↑	30.4	38%	284
9	Sharp	1↑	31.6	40%	284
10	Datang Telecom	3↓	22.3	21%	266
11	Interdigital	↔	34.3	42%	208
12	Alphabet	3↑	31.2	40%	142
13	NEC	3↑	32.2	41%	141
14	Apple	2↓	27.4	28%	131
15	Sony	3↑	32.0	40%	117
16	BlackBerry	4↑	38.3	54%	116
17	OPPO & One Plus	3↓	25.5	24%	89
18	Fujitsu	1↓	20.4	23%	77
19	ETRI	6↓	16.6	7%	30
20	Kyocera	1↓	17.4	1%	1

4G Stack: Portfolio Family Global Value Analysis (3/3) - Visualization



Based on the data presented on the previous slide, Tech+IP then graphed the global Family coverage data as follows: the bubble size shows a company's total Value Family Count; the x-axis represents average TIP Family Coverage Score on a company level; the y-axis represents the percentage of Families in the company's portfolio with 38+ TIP Family Coverage Score.

As the data for 5G declarations and global coverage become more stable – and the methodology behind the calculations peer reviewed and critiqued, Tech+IP is planning on performing the same type of analysis for 5G Families.

Definitions and Methodology for Patent & Declaration Data (1/3)

- Patent data is derived from the Innography ® database (owned by Clarivate) and follows the industry-standard Innography **INPADOC Family** (e.g., group of assets sharing priority characteristics) and **Assets** (e.g., published patent applications and issued patents (aka "**Grants**")) definitions. Only "active" Assets (e.g., published, unexpired and not abandoned per Innography as of December 31, 2021) are counted herein. Additionally, only the first named owner (the Innography "ultimate parent") for any Asset was counted or listed.
- SEP declaration data is based on ETSI's Dynamic Report[(1)] declaration data as of December 31, 2021.
- **Core Global** includes the following jurisdictions: the United States, China, Germany, France, Great Britain, Netherlands and EPO Assets.
- **Core EP** includes the following jurisdictions: Germany, France, Great Britain, Netherlands and EPO Assets.
- **Core Asia** includes the following jurisdictions: China, Japan, Taiwan, South Korea.
- **Fast Growth** includes the following jurisdictions: India, Brazil, Indonesia, Malaysia.
- **ETSI TS Label:** Field in ETSI database that indicates technical specification ("TS") to which assets are declared (e.g. TS 36.213, TS 24.312, etc.). Any apparently erroneous TS data indicated in the field was excluded from the present analysis (e.g., TS which is not available on 3GPP list of published TSs such as TS 36.210, TS 36.311, etc.).
- **ETSI Project Label:** Field in ETSI database that indicates project to which assets are declared (e.g, UMTS, LTE, New Radio ("NR" for 5G), etc.). Any apparently erroneous, generic, or blank project names indicated in the field were excluded from the present analysis (e.g., 3GPP, Speech Recognition, Security, etc.). Generations are generically referred to herein as "Gs".[(2)]

(1) ETSI Dynamic Report: https://ipr.etsi.org/DynamicReportingResult.aspx
(2) ETSI TS Label takes precedence over ETSI Project Label in the event of conflicting data between said two labels in ETSI declarations.

Definitions and Methodology for Patent & Declaration Data (2/3)

- **Single Generation (Single XG):** According to 3GPP website[1], the TS indicated in the appropriate Label is applicable to a single Generation.
- **Multi Generation (Multi XGs):** According to 3GPP website[2], the TS indicated in the appropriate Label is applicable to two or more Generations.
- **Declared to ETSI Project Only:** If the Release number for a specific TS is not provided, but ETSI project field indicates a specific G, those declarations are marked as declared to "Declared to ETSI project only".
- **Potential SEP:** Other Family members that are not explicitly declared by declaring company to ETSI
- **TIP Family Coverage Score:** When evaluating TIP Family Coverage score, Tech+IP considered multiple regional market, rate, and enforcement factors (**we hope to further validate and refine this approach with community comments and help**):
  - *Regional Importance*: The relevant license rate factor for each region. It is either a rate of 1.0 or 0.65. The initial version of this factor is based on the Chinese antitrust case *Qualcomm vs NDRC*.[3]
  - *Regional Sales*: The percentage market share of wireless handset sales for each region in aggregate.[4]
  - *Jurisdictional Adjustment:* A rough qualitative assessment by Tech+IP based on the utility of patent enforcement mechanisms and additional factors for each region/country, including the ability to receive and implement an injunction, the efficiency of the court system, and differences in the treatment and application of FRAND for local vs. foreign parties, among other factors.
  - *TIP Family Coverage Score Add-on*: Adjustment for Families with multiple Assets in the same region/country. Additional 1 to 4 points are added according to the 2nd table on slide 26.
- **Core TSs for 4G [5G]:** Group of technical specifications that define major improvements and enablers in 4G [5G] standard according to Tech+IP team. Mostly covered of technical standard (TS) series 36 [38] and closely related to series of TSs with initial release 8 [initial release 15].

(1) See, e.g., "Radio Technology" tab here https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=2437
(2) See, e.g., "Radio Technology" tab here https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=584
(3) https://www.iam-media.com/frandseps/qualcomm-antitrust-decision-could-be-the-big-bang-moment-chinas-domestic-patent-market
(4) https://www.statista.com/outlook/cmo/consumer-electronics/telephony/smartphones/worldwide

Definitions and Methodology for Patent & Declaration Data (3/3)

- **Full List of 156 TIP identified Core TSs for 4G:**

TS 22.220	TS 23.521	TS 24.451	TS 25.321	TS 29.274	TS 32.451	TS 36.101	TS 36.300	TS 36.401	TS 36.443	TS 36.523-3
TS 22.278	TS 24.008	TS 24.503	TS 25.322	TS 29.275	TS 32.500	TS 36.104	TS 36.302	TS 36.410	TS 36.444	TS 37.320
TS 23.214	TS 24.182	TS 24.604	TS 25.331	TS 29.276	TS 32.501	TS 36.106	TS 36.304	TS 36.411	TS 36.445	TS 37.460
TS 23.216	TS 24.237	TS 24.605	TS 25.367	TS 29.277	TS 32.502	TS 36.113	TS 36.305	TS 36.412	TS 36.461	TS 37.461
TS 23.237	TS 24.239	TS 24.606	TS 25.446	TS 29.279	TS 32.503	TS 36.116	TS 36.306	TS 36.413	TS 36.462	TS 37.462
TS 23.255	TS 24.285	TS 24.607	TS 25.467	TS 29.280	TS 32.505	TS 36.124	TS 36.307	TS 36.414	TS 36.463	TS 37.466
TS 23.272	TS 24.286	TS 24.608	TS 25.469	TS 29.282	TS 32.511	TS 36.133	TS 36.311	TS 36.420	TS 36.464	
TS 23.292	TS 24.292	TS 24.610	TS 29.118	TS 29.292	TS 32.521	TS 36.141	TS 36.312	TS 36.421	TS 36.465	
TS 23.334	TS 24.301	TS 24.611	TS 29.165	TS 29.303	TS 32.537	TS 36.143	TS 36.314	TS 36.422	TS 36.508	
TS 23.380	TS 24.302	TS 24.615	TS 29.168	TS 29.305	TS 32.752	TS 36.201	TS 36.321	TS 36.423	TS 36.509	
TS 23.401	TS 24.303	TS 24.616	TS 29.235	TS 29.334	TS 32.753	TS 36.211	TS 36.322	TS 36.424	TS 36.521-1	
TS 23.402	TS 24.304	TS 25.211	TS 29.238	TS 29.364	TS 32.762	TS 36.212	TS 36.323	TS 36.425	TS 36.521-2	
TS 23.506	TS 24.312	TS 25.212	TS 29.244	TS 32.274	TS 32.763	TS 36.213	TS 36.331	TS 36.440	TS 36.521-3	
TS 23.507	TS 24.323	TS 25.214	TS 29.272	TS 32.426	TS 33.320	TS 36.214	TS 36.360	TS 36.441	TS 36.523-1	
TS 23.517	TS 24.447	TS 25.304	TS 29.273	TS 32.450	TS 33.401	TS 36.216	TS 36.361	TS 36.442	TS 36.523-2	

- **Full List of 161 TIP identified Core TSs for 5G:**

TS 21.205	TS 23.548	TS 26.117	TS 28.532	TS 29.504	TS 29.522	TS 32.255	TS 38.101-1	TS 38.211	TS 38.401	TS 38.460	TS 38.521-3
TS 22.186	TS 23.558	TS 26.250	TS 28.533	TS 29.505	TS 29.523	TS 32.256	TS 38.101-2	TS 38.212	TS 38.410	TS 38.461	TS 38.521-4
TS 23.247	TS 24.008	TS 26.251	TS 28.535	TS 29.507	TS 29.524	TS 32.290	TS 38.101-3	TS 38.213	TS 38.411	TS 38.462	TS 38.522
TS 22.261	TS 24.174	TS 26.253	TS 28.540	TS 29.508	TS 29.525	TS 32.291	TS 38.101-4	TS 38.214	TS 38.412	TS 38.463	TS 38.523-1
TS 23.273	TS 24.501	TS 26.256	TS 28.541	TS 29.509	TS 29.531	TS 33.122	TS 38.104	TS 38.215	TS 38.413	TS 38.470	TS 38.523-2
TS 23.286	TS 24.502	TS 26.258	TS 28.545	TS 29.510	TS 29.540	TS 33.501	TS 38.113	TS 38.300	TS 38.414	TS 38.471	TS 38.523-3
TS 23.287	TS 24.519	TS 26.501	TS 28.550	TS 29.511	TS 29.551	TS 33.512	TS 38.124	TS 38.304	TS 38.415	TS 38.472	TS 38.533
TS 23.288	TS 24.526	TS 26.511	TS 28.552	TS 29.512	TS 29.554	TS 33.513	TS 38.133	TS 38.306	TS 38.420	TS 38.473	
TS 23.304	TS 24.587	TS 26.512	TS 28.554	TS 29.513	TS 29.561	TS 33.535	TS 38.141-1	TS 38.314	TS 38.421	TS 38.474	
TS 23.316	TS 25.211	TS 28.104	TS 29.413	TS 29.514	TS 29.571	TS 34.229-5	TS 38.141-2	TS 38.321	TS 38.422	TS 38.508-1	
TS 23.501	TS 25.212	TS 28.201	TS 29.500	TS 29.518	TS 29.572	TS 37.107	TS 38.171	TS 38.322	TS 38.423	TS 38.508-2	
TS 23.502	TS 25.214	TS 28.312	TS 29.501	TS 29.519	TS 29.573	TS 37.213	TS 38.174	TS 38.323	TS 38.424	TS 38.509	
TS 23.503	TS 25.321	TS 28.530	TS 29.502	TS 29.520	TS 29.594	TS 37.324	TS 38.201	TS 38.331	TS 38.425	TS 38.521-1	
TS 23.527	TS 25.331	TS 28.531	TS 29.503	TS 29.521	TS 32.254	TS 37.340	TS 38.202	TS 38.340	TS 38.455	TS 38.521-2	

4G-5G SEP Landscape Update -- Patent Data Limitations

In addition to its own proprietary databases, Tech+IP uses the Innography® database for patent metadata and the LexMachina® and DartsIP® databases for patent litigation data. The public databases include limitations which may impact the analysis, without significantly changing results.

- **Innography Limitations**
  - Innography patent ownership, expiration, abandonment and citation data may be erroneous (for time lag and other reasons) for non-US jurisdictions
  - Innography data does not include assets filed in the following jurisdictions (all are listed in the ETSI database): Andorra, Afghanistan, Antigua and Barbuda, Barbados, Bangladesh, Bolivia, Bhutan, Belize, Dominica, Grenada, Ghana, Gambia, Kuwait, Saint Lucia, Sri Lanka, Liberia, Lesotho, Madagascar, Malawi, Mozambique, Namibia, Nepal, Oman, Pakistan, Sudan, Sierra Leone, USSR, Swaziland, Thailand, Trinidad and Tobago, Tanzania, Uzbekistan, Venezuela, Vietnam, Zambia and Zimbabwe
  - Innography data includes only published applications and does not include granted patents for the following jurisdictions (all are listed in the ETSI database): Colombia, Costa Rica, Dominican Republic, Ecuador, Honduras, Israel, New Zealand, Panama, Peru and Tunisia
  - Innography data includes only EP grants filed through European Patent Office (EPO) and does not include nationalized EP grants
- **LexMachina Limitations**
  - LexMachina relevant data includes only patent litigation data related to US district courts and the ITC
- **DartsIP Limitations**
  - DartsIP does not provide information on case outcome or status
  - Information available varies depending on specific jurisdiction, not consistent

4G Stack: Specification Breakdown (Families and Granted Patents)

The tables below provide TS information on 4G Families and Grants. All five top TS declarations are in TS 36. Specifications addressing 4G PHY layer aspects comprise three out the top five most declared 4G TSs.

Families

SEP Status	# of Families	% of Families
Multi Generation (Multi XGs)	11,551	51.2%
Single Generation (Single XG)	10,591	46.9%
Declared to ETSI Project only	429	1.9%
Total	**22,571**	**100.0%**

Top 5 TS Declarations	TS Name	# of Families[1]	% of Families
TS 36.331	E-UTRA; RRC; Protocol specification	13,149	58%
TS 36.213	E-UTRA; Physical layer procedures	12,833	57%
TS 36.211	E-UTRA; Physical channels and modulation	11,856	53%
TS 36.300	E-UTRA and E-UTRAN; Overall description; Stage 2	10,997	49%
TS 36.212	(E-UTRA); Multiplexing and channel coding	9,384	42%

Granted Patents

SEP Status	# of Granted Patents	% of Granted Patents
Multi Generation (Multi XGs)	55,655	50.4%
Single Generation (Single XG)	44,058	39.9%
Potential SEP	9,018	8.2%
Declared to ETSI Project only	1,737	1.6%
Total	**110,468**	**100.0%**

Top 5 TS Declarations	TS Name	# of Granted Patents[1]	% of Granted Patents
TS 36.213	(E-UTRA); Physical layer procedures	53,427	48%
TS 36.331	(E-UTRA); Radio Resource Control (RRC); Protocol specification	47,769	43%
TS 36.211	(E-UTRA); Physical channels and modulation	45,060	41%
TS 36.300	E-UTRA and E-UTRAN; Overall description; Stage 2	40,377	37%
TS 36.212	(E-UTRA); Multiplexing and channel coding	30,990	28%

(1) There is a significant overlap in counts because families and assets can be declared to multiple generations.

5G Stack: Specification Breakdown (Families and Grants)

Specifications addressing 5G PHY layer aspects comprise four of the top five most declared 5G TSs per Families, with the fifth TS directed to RRC protocols. All five TSs in case of Family counts are 38, whereas two out of five TSs in case of Grants counts are 36 and the rest are 38.

Families

SEP Status	# of Families	% of Families
Single Generation (Single XG)	23,933	67.4%
Multi Generation (Multi XGs)	11,551	32.5%
Declared to ETSI Project only	46	0.1%
Total	**35,530**	**100.0%**

Top 5 TS Declarations	TS Name	# of Families[1]	% of Families
TS 38.331	(E-UTRA); Physical layer procedures	17,673	50%
TS 38.213	NR; Physical layer procedures for control	16,951	48%
TS 38.214	(E-UTRA);(RRC); Protocol specification	13,839	39%
TS 38.211	NR; (RRC); Protocol specification	13,806	39%
TS 38.212	NR; Physical channels and modulation	12,804	36%

Granted Patents

SEP Status	# of Granted Patents	% of Granted Patents
Multi Generation (Multi XGs)	55,655	52.9%
Single Generation (Single XG)	37,923	36.0%
Potential SEP	11,441	10.9%
Declared to ETSI Project only	238	0.2%
Total	**105,257**	**100.0%**

Top 5 TS Declarations	TS Name	# of Granted Patents[1]	% of Granted Patents
TS 38.213	NR; Physical layer procedures for control	41,042	39%
TS 38.331	(E-UTRA); Physical layer procedures	38,808	37%
TS 38.211	NR; (RRC); Protocol specification	34,078	32%
TS 38.214	(E-UTRA);(RRC); Protocol specification	33,644	32%
TS 38.212	NR; Physical channels and modulation	27,165	26%

(1) There is a significant overlap in counts because families and assets can be declared to multiple generations.

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