



**Tech+IP Advisory, LLC**

Creating Tangible Value From Intangible Assets™

# 4G-5G SEPs Are Global Assets in the Year of the Ox

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Q1 2021 4G-5G Standard Essential Patent (SEP) Market Report & Analysis

February 15, 2021

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San Francisco | Sarajevo | Washington, DC | Taipei

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## 4G-5G SEP Update and Key Takeaways

Tech+IP believes that beyond providing an important update of cellular telecommunications Standard Essential Patents (SEPs), this 2021 update has a special urgency given changes in the law, markets and filing/declaration practices of SEP owners. **Changes that occurred in 2020 clearly teach two things: (1) SEPs are now “global assets” and (2) more sophisticated analyses of SEP patent stacks – such as by technical subject matter (declared technical specification (“TS”)) and geographic region covered are needed for more economically rational FRAND rates and SEP count calculations. A central purpose of this update is to facilitate this more nuanced conversation (leaving behind “lumped together” approaches). Tech+IP posits that while all SEPs are equal, some SEPs are more equal than others.**

- In 2020, courts became increasingly willing to venture into determining global FRAND rates as patent owners and implementers fought in multiple jurisdictions. This development also drove settlements and transactions.

*See, e.g., Unwired Planet v. Huawei* (UK Supreme Court) August 2020 (settled); *Sisvel v. Haier* (German BGH) May 2020; *Huawei v. Interdigital* (Shenzhen Intermediate Court and UK Patents Court) April 2020 (settled); *But c.f. Conversant v Huawei* (Nanjing Intermediate Court) Sep 2019 (though it, too, settled)

- In Q4 2020 approximately 5900 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 192,000 (at least according to their owners).

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

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- Despite the staggering number of patents potentially necessary for any 4G-5G compliant mobile handset or network, however, there is almost no public discussion of:
  - What Assets map to which technical specifications (“TSs”) and why that matters
  - What patent families are truly global (and deserving of premium FRAND rates)
  - What patent families are merely regional or national (and deserving of lower FRAND rates)
- Beyond technical and geographic data, the breakdown of SEPs often ignores the markets in which compliant devices are made, used or sold despite real world evidence that royalty rates often differ based on these factors (especially if a particular company’s market share is concentrated in one or more differing regions)
- The goal of this 4G-5G SEP Update report is 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.

**This report is updated quarterly. Tech+IP continues to track substantial additional 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.**

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

As of January 1, 2021, ~40k patent Families, encompassing ~192k Assets, have been declared by their owners to be essential to 4G-5G. ~5,900 Assets were newly declared in Q4 2020. Qualcomm, Xiaomi and NTT led in number of new declarations; while Xiaomi, Vivo and Sharp led in percentage increase terms. See Appendix for definitions.

#	Patent Owner	Family Breakdown		Assets Breakdown				Asset to Family Ratios		# of New Declarations (Q4 2020)	% of New Declarations (Q4 2020) out of 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	5,722	14.5%	23,990	12.5%	11,758	11.3	4.2	2.1	8	0.1%
2	Qualcomm	3,748	9.5%	32,754	17.0%	19,477	8.7	8.7	5.2	<b>689</b>	<b>11.8%</b>
3	ZTE	3,673	9.3%	6,950	3.6%	2,824	10.5	1.9	0.8	479	8.1%
4	Nokia	3,217	8.1%	12,757	6.6%	9,315	7.9	4.0	2.9	475	8.0%
5	Samsung	3,182	8.0%	15,038	7.8%	9,031	9.5	4.7	2.8	502	8.5%
6	LGE	2,923	7.4%	14,914	7.8%	10,374	10.4	5.1	3.5	400	6.8%
7	Datang Telecom	2,510	6.3%	4,879	2.5%	2,198	11.6	1.9	0.9	265	4.5%
8	Ericsson	1,626	4.1%	11,123	5.8%	6,174	10.1	6.8	3.8	0	
9	NTT	1,450	3.7%	5,856	3.0%	3,179	9.3	4.0	2.2	<b>567</b>	<b>9.6%</b>
10	Sharp	1,289	3.3%	5,041	<b>2.6%</b>	2,947	10.9	3.9	2.3	318	<b>5.4%</b>
11	Interdigital	970	2.5%	8,544	4.4%	5,443	7.7	8.8	5.6	162	2.7%
12	Xiaomi	833	2.1%	1,516	<b>0.8%</b>	361	12.1	1.8	0.4	<b>640</b>	<b>10.8%</b>
13	Apple	755	1.9%	6,743	3.5%	4,801	10.2	8.9	6.4	0	
14	Vivo	619	1.6%	1,039	<b>0.5%</b>	80	10.6	1.7	0.1	505	<b>8.5%</b>
15	ETRI	539	1.4%	1,356	0.7%	1,016	8.5	2.5	1.9	0	
16	BBK Electronics <sup>(1)</sup>	532	1.3%	3,409	1.8%	911	10.7	6.4	1.7	0	
17	Intel	526	1.3%	2,221	1.2%	1,106	10.4	4.2	2.1	0	
18	Alphabet	421	1.1%	2,019	1.1%	1,763	6.6	4.8	4.2	0	
19	NEC	404	1.0%	3,821	2.0%	2,661	9.9	9.5	6.6	160	2.7%
20	Fujitsu	359	0.9%	1,655	0.9%	1,396	8.2	4.6	3.9	0	
21	Others	4,256	10.8%	26,548	13.8%	19,220	9.7	6.2	4.5	739	12.5%
<b>TOTAL</b>		<b>39,554</b>	<b>100.0%</b>	<b>192,173</b>	<b>100.0%</b>	<b>116,035</b>	<b>9.4</b>	<b>4.9</b>	<b>2.9</b>	<b>5,909</b>	<b>100%</b>

(1) OPPO and OnePlus are recorded under BBK Electronics.

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

Among Families declared to both 5G and 4G, the Core Global jurisdictions grouping (Families having Assets in China, Asia ex-China, Europe and the US) includes the most Families, Assets and the most new declarations. Of company declarants, Huawei leads total family counts across all geographic regions except “Fast Growth” regions. Perhaps indicating regional importance, Qualcomm now has more Assets in the Fast Growth countries than in Europe.

#	Patent Owner	Core Global <sup>(1)</sup>			Core EP			Core Asia			Fast Growth		
		# of Families	# of Assets	New Declarations	# of Families	# of Assets	New Declarations	# of Families	# of Assets	New Declarations	# of Families	# of Assets	New Declarations
1	Huawei	<b>5,695</b>	17,498	0.2%	<b>3,932</b>	4,703	0.3%	<b>5,374</b>	9,146	0.1%	1,495	1,922	1.0%
2	Qualcomm	3,557	13,153	9.1%	2,619	3,832	13.7%	3,196	12,371	9.8%	<b>2,206</b>	<b>3,975</b>	38.0%
3	ZTE	3,507	5,595	10.3%	988	1,013	7.1%	3,450	4,083	10.2%	166	211	3.0%
4	Nokia	3,088	7,636	11.6%	2,301	2,644	17.4%	2,001	3,908	6.3%	802	1,007	2.0%
5	Samsung	3,012	9,353	7.6%	1,876	2,495	8.0%	2,633	5,766	6.3%	751	921	
6	LGE	2,711	9,559	5.8%	1,469	2,178	7.5%	1,844	5,483	5.1%	396	631	7.0%
7	Datang Telecom	2,503	3,758	4.5%	631	642		2,485	3,380	7.1%	67	67	
8	Ericsson	1,520	5,441		1,343	1,834		1,216	2,395		822	1,117	
9	Sharp	1,071	2,963	6.2%	701	760	7.7%	1,188	2,174	2.9%	201	257	19.0%
10	NTT	1,069	2,949	7.8%	826	914	10.9%	1,225	2,456	7.9%	438	563	10.0%
11	Xiaomi	832	1,320	12.9%	182	201	6.6%	805	896	13.6%	39	48	3.0%
12	Interdigital	732	3,216	1.9%	503	770	2.4%	871	3,968	3.1%	288	523	3.0%
13	Apple	710	4,059		338	902		420	2,188		80	313	
14	Vivo	618	868	8.2%	129	133	4.3%	613	629	9.0%	6	8	1.0%
15	BBK Electronics	532	1,542		388	486		404	1,093		201	250	
16	Intel	455	1,310		235	294		260	686		73	109	
17	Alphabet	401	1,034		202	279		277	712		152	211	
18	ETRI	370	737		83	129		455	666		7	15	
19	NEC	357	1,971	2.7%	295	545	3.2%	373	1,656	3.2%	118	225	6.0%
20	Lenovo	237	746		158	198		189	382		57	71	
21	Others	3,679	14,676	11.2%	2,186	3,801	10.9%	3,598	10,127	15.4%	927	1,585	7.0%
<b>TOTAL (# not %)</b>		<b>36,656</b>	<b>109,384</b>	<b>3,531</b>	<b>21,385</b>	<b>28,753</b>	<b>788</b>	<b>32,877</b>	<b>74,165</b>	<b>2,437</b>	<b>9,292</b>	<b>14,029</b>	<b>100</b>

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

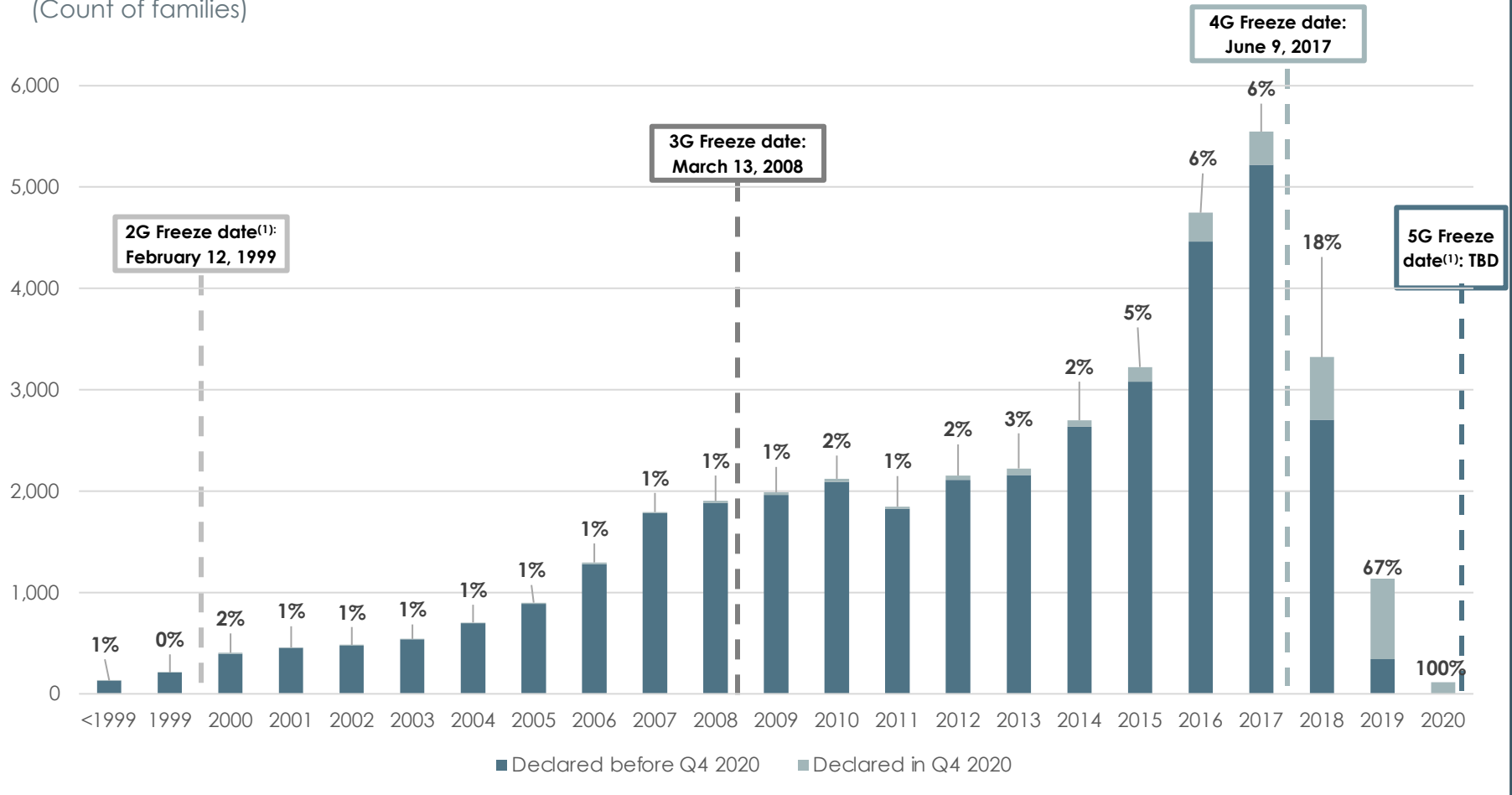


# 4G-5G Comprehensive Stack: Priority Dates Breakdown

5G declarations are being filed at a faster pace than any prior Generation. For earlier Generations (2G/3G), many of the Families have a priority date after the relevant technical specification freeze date. That is not true, however, for 5G and, to a large extent, 4G as well.

## Priority Dates and 2G/3G/4G Standard Freeze Dates

(Count of families)



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

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# 5G Stack: SEP Family and Asset Counts

Based on declarations, the 5G stack comprises ~30k Families and ~150k Assets worldwide. Approximately 73% of 5G families are declared to TS 38 series specifications, which was/is the initial series of the 5G standard. Among 5G declarants, Huawei leads in Family counts, but Qualcomm has higher total numbers and a higher number of new declarations filed.

#	Patent Owner	Family Breakdown				Assets Breakdown				Asset to Family Ratios		# of New Declarations (Q4 2020)	% of New Declarations (Q4 2020) 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	<b>4,678</b>	<b>15.2%</b>	3,704	16.5%	20,084	13.4%	9,204	11.9	4.3	2.0	8	0.1%
2	ZTE	3,340	10.8%	2,262	10.1%	6,651	4.4%	2,430	10.6	2.0	0.7	479	8.4%
3	Qualcomm	3,149	10.2%	2,434	10.9%	<b>27,140</b>	<b>18.1%</b>	15,365	8.7	8.6	4.9	<b>689</b>	<b>12.1%</b>
4	Nokia	2,997	9.7%	1,480	6.6%	11,967	8.0%	8,477	8.0	4.0	2.8	475	8.3%
5	Samsung	2,967	9.6%	2,737	12.2%	14,350	9.6%	8,257	9.6	4.8	2.8	502	8.8%
6	LGE	2,213	7.2%	1,753	7.8%	12,163	8.1%	8,258	10.4	5.5	3.7	400	7.0%
7	Datang Telecom	1,517	4.9%	1,204	5.4%	2,916	1.9%	458	14.7	1.9	0.3	265	4.7%
8	NTT	1,413	4.6%	754	3.4%	6,129	4.1%	3,146	9.3	4.3	2.2	567	10.0%
9	Ericsson	1,256	4.1%	933	4.2%	8,747	5.8%	4,733	10.2	7.0	3.8	0	
10	Sharp	1,222	4.0%	1,090	4.9%	4,876	3.3%	2,863	11.0	4.0	2.3	307	5.4%
11	Interdigital	640	2.1%	328	1.5%	6,731	4.5%	4,322	7.5	10.5	6.8	162	2.8%
12	Xiaomi	631	2.0%	496	2.2%	1,389	0.9%	272	12.2	2.2	0.4	572	10.0%
13	Vivo	617	2.0%	589	2.6%	1,243	0.8%	74	10.7	2.0	0.1	505	8.9%
14	Apple	474	1.5%	347	1.5%	4,931	3.3%	3,344	11.2	10.4	7.1	0	
15	Intel	399	1.3%	337	1.5%	1,511	1.0%	636	9.9	3.8	1.6	0	
16	BBK Electronics	340	1.1%	306	1.4%	2,383	1.6%	223	12.3	7.0	0.7	0	
17	Lenovo	222	0.7%	150	0.7%	860	0.6%	287	10.4	3.9	1.3	0	
18	Mediatek	217	0.7%	196	0.9%	1,323	0.9%	832	13.4	6.1	3.8	0	
19	NEC	214	0.7%	70	0.3%	2,277	1.5%	1,526	9.7	10.6	7.1	143	2.5%
20	ETRI	214	0.7%	182	0.8%	792	0.5%	493	8.7	3.7	2.3	0	
21	Others	2,114	6.9%	1,063	4.7%	11,488	7.7%	8,455	10.5	5.4	4.0	618	10.9%
	<b>TOTAL</b>	<b>30,834</b>	<b>100.0%</b>	<b>22,415</b>	<b>100.0%</b>	<b>149,951</b>	<b>100.0%</b>	<b>83,655</b>	<b>9.5</b>	<b>4.9</b>	<b>2.7</b>	<b>5,692</b>	<b>100%</b>

# 5G Stack: Coverage of Key Geographic Regions

Legal and market changes in 2020 (and licensing practices even earlier) mean that SEPs can not simply be lumped together with geographic analysis ignored. Even if Global FRAND becomes widely adopted, implementor companies have great disparities in where sales are concentrated and the product mix of handset features and associated pricing. Following “Fast Growth” and other market segments is now a practical necessity.

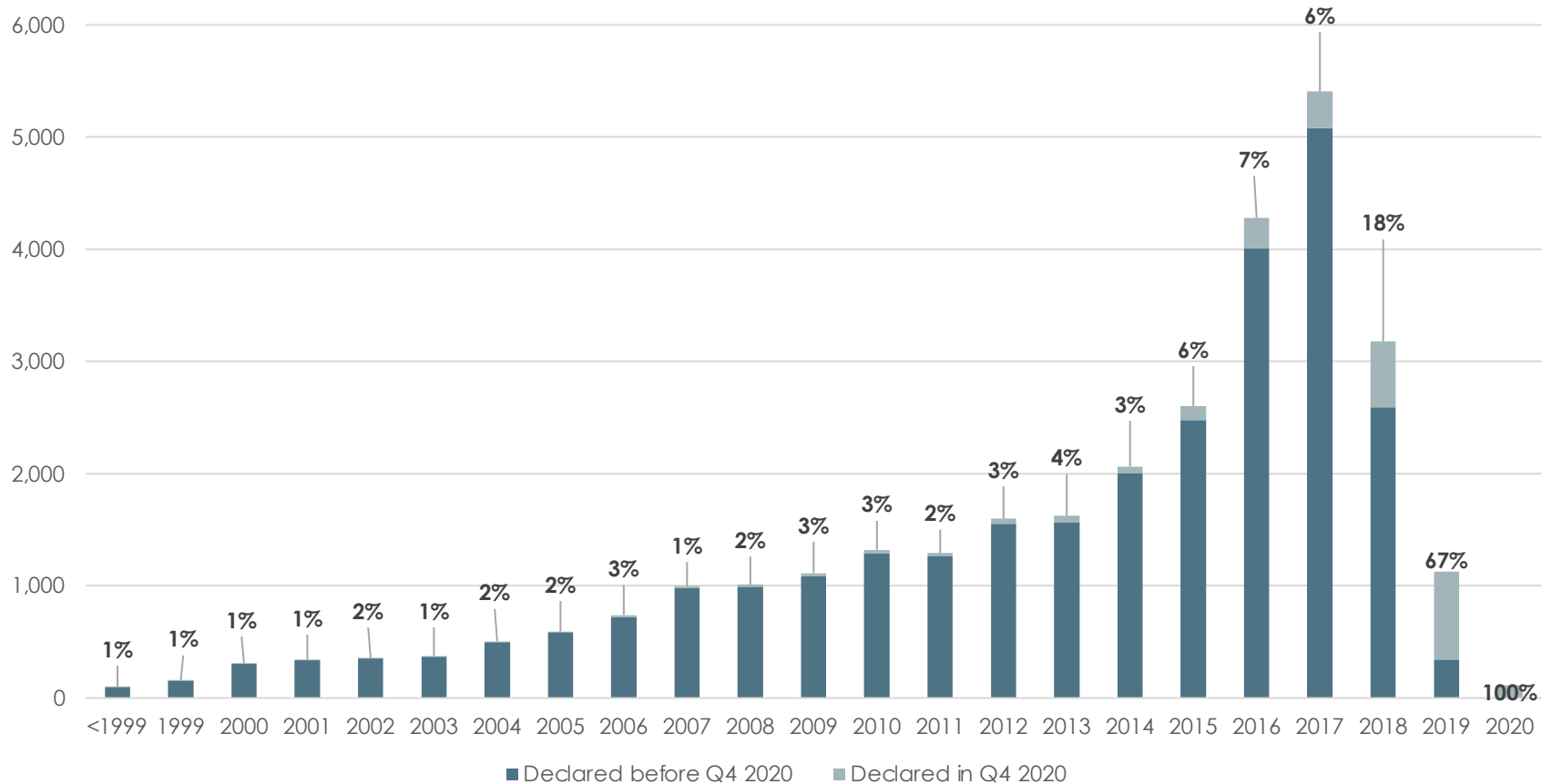
#	Patent Owner	Core Global			Core EP			Core Asia			Fast Growth		
		# of Families	# of Assets	New Declarations	# of Families	# of Assets	New Declarations	# of Families	# of Assets	New Declarations	# of Families	# of Assets	New Declarations
1	Huawei	<b>4,659</b>	<b>14,729</b>	0.2%	<b>3,398</b>	<b>4,002</b>	0.3%	<b>4,377</b>	<b>7,494</b>	0.1%	1,256	1,595	1.0%
2	ZTE	3,175	5,143	10.6%	936	961	7.3%	3,126	3,718	10.7%	154	196	3.1%
3	Qualcomm	3,030	11,075	9.5%	2,192	3,228	14.1%	2,670	9,983	10.2%	<b>1,724</b>	<b>3,148</b>	39.6%
4	Nokia	2,892	7,104	12.0%	2,169	2,465	18.0%	1,844	3,577	6.6%	726	910	2.1%
5	Samsung	2,825	8,817	7.8%	1,775	2,361	8.3%	2,473	5,349	6.6%	707	861	
6	LGE	2,083	7,718	6.0%	1,158	1,745	7.7%	1,381	4,426	5.4%	295	492	7.3%
7	Datang Telecom	1,514	2,136	4.7%	326	328		1,510	2,033	7.5%	10	10	
8	NTT	1,052	2,916	8.1%	819	907	11.3%	1,203	2,423	8.3%	413	536	10.5%
9	Ericsson	1,198	4,297		1,063	1,426		970	1,914		642	886	
10	Sharp	1,041	2,859	6.1%	676	732	7.5%	1,128	2,075	2.9%	190	244	19.8%
11	Interdigital	520	2,546	2.0%	405	639	2.5%	570	3,006	3.2%	207	407	3.1%
12	Xiaomi	630	1,013	12.2%	139	151	6.8%	615	691	12.6%	25	28	3.1%
13	Vivo	616	863	8.5%	127	131	4.5%	612	628	9.5%	4	6	1.0%
14	Apple	435	2,765		223	695		272	1,593		36	230	
15	Intel	328	886		158	201		180	460		43	68	
16	BBK Electronics	340	954		265	288		307	918		161	170	
17	Lenovo	206	635		137	168		160	300		44	52	
18	Mediatek	217	913		133	200		202	521		72	153	
19	NEC	196	1,141	2.4%	172	327	3.0%	198	978	2.9%	51	121	6.3%
20	ETRI	186	471		61	99		204	349		6	14	
21	Others	1,771	6,228	9.9%	984	1,715	8.7%	1,706	4,383	13.5%	402	594	3.1%
	<b>TOTAL (# not %)</b>	<b>28,914</b>	<b>85,209</b>	<b>3,415</b>	<b>17,316</b>	<b>22,769</b>	<b>762</b>	<b>25,708</b>	<b>56,819</b>	<b>2,326</b>	<b>7,168</b>	<b>10,721</b>	<b>96</b>

# 5G Stack: Priority Dates Breakdown

83% of newly declared Families have priority year between 2015-2020, while 62% of prior declared Families claim priorities from 2013-2018. Not surprisingly, the largest number of new declarations in Q4 2020 claim 2019 priority.

## Priority Dates

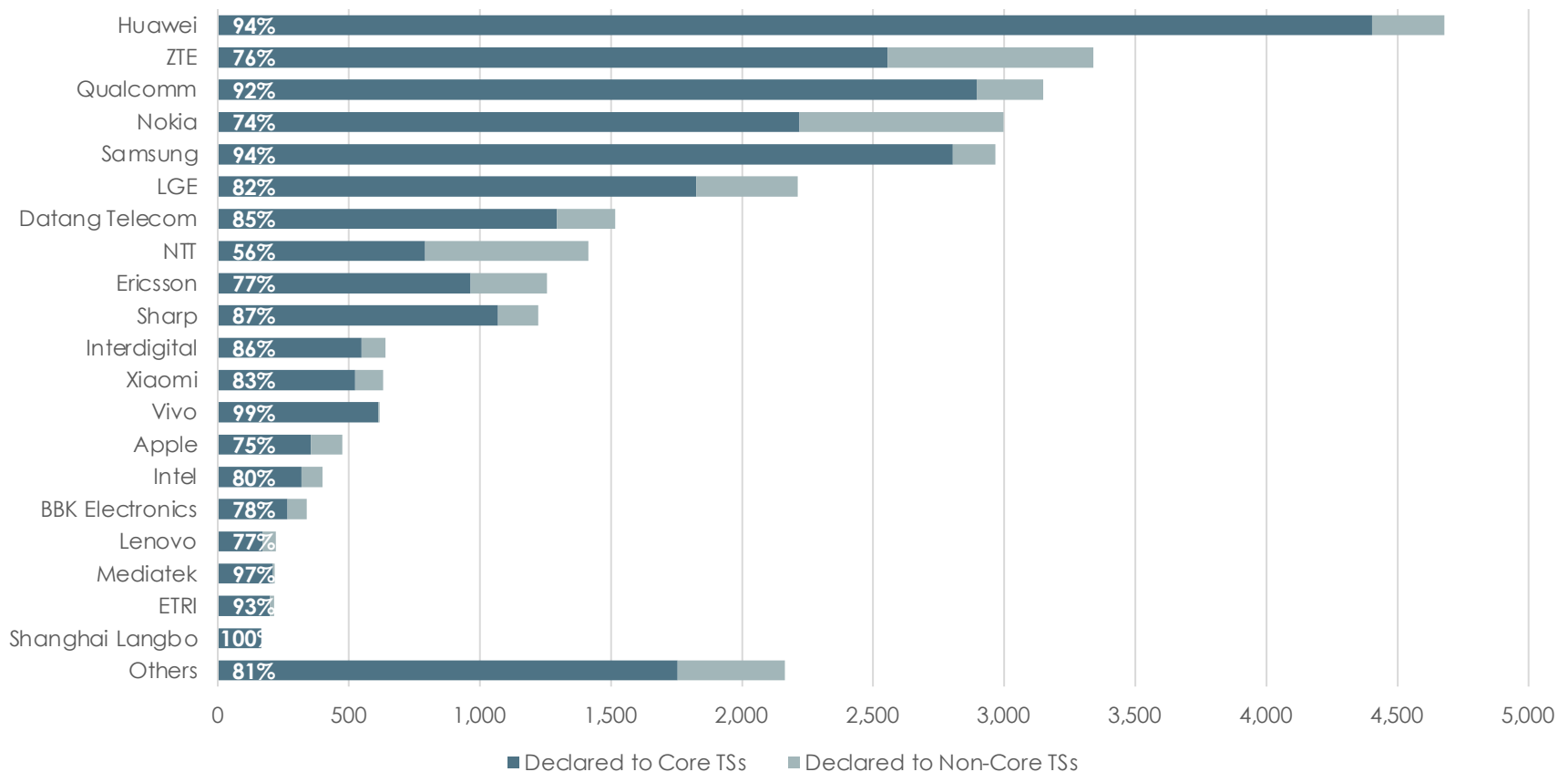
(Count of families)



# 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, the reality is that all SEPs should not be “equal.” One way to assess this is to categorize SEPs by the TS to which they apply. We have proposed a grouping of “core TSs” (see the appendix to this document and the link below). Tech+IP identified 38% of all 5G TSs as core 5G-related TSs. 84% of the total 5G families are declared to core TSs.

(Count of families)



(1) Tech+IP breakdown of TSs to Core Vs. Non-core: <https://app.box.com/file/763647358216>.

# 5G Stack: Technical Standards Per Priority Dates Breakdown

Taking the TS analysis further, the most frequent TSs to which 5G families have been declared are 38.2xx and 38.3xx. Most of these 5G families have a priority year between 2015-2020.

TS Number	TS Name	Priority Date				
		2016	2017	2018	2019	2020
TS 38.213	NR; Physical layer procedures for control	15%	16%	16%	18%	15%
TS 38.331	NR; Radio Resource Control (RRC); Protocol specification	14%	15%	18%	20%	20%
TS 38.211	NR; Physical channels and modulation	13%	13%	11%	9%	14%
TS 38.214	NR; Physical layer procedures for data	13%	11%	12%	11%	14%
TS 38.212	NR; Multiplexing and channel coding	13%	12%	11%	12%	13%
TS 38.300	NR; NR and NG-RAN Overall description; Stage-2	9%	8%	6%	5%	4%
TS 38.321	NR; Medium Access Control (MAC) protocol specification	7%	8%	8%	9%	4%
TS 38.322	NR; Radio Link Control (RLC) protocol specification	3%	2%	1%	1%	0%
TS 23.501	System architecture for the 5G System (5GS)	2%	2%	2%	1%	1%
TS 23.502	Procedures for the 5G System (5GS)	1%	1%	1%	1%	0%

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# 4G Stack: SEP Family and Asset Counts

The 4G stack comprises ~23k Families and ~143k Assets. Approximately 74% of all 4G families are declared to TS 36 series specifications, the initial series of the 4G standard. Huawei and Qualcomm practices roughly mirror the earlier 5G discussion. Samsung leads in TS 36 and ZTE and Sharp (in that order) lead in the number of new 4G declarations. LG's portfolio (sixth place in Family count) may be significant based on Q1 2021 business news.

#	Patent Owner	Family Breakdown				Assets Breakdown				Asset to Family Ratios		# of New Declarations (Q4 2020)	% of New Declarations (Q4 2020) 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	<b>2,866</b>	<b>12.3%</b>	1,587	9.2%	13,304	9.3%	7,741	10.2	4.6	2.7	0	
2	Qualcomm	2,074	8.9%	1,457	8.5%	<b>23,905</b>	<b>16.7%</b>	16,234	8.2	11.5	7.8	191	11.1%
3	Samsung	2,027	8.7%	<b>1,775</b>	<b>10.3%</b>	11,636	8.1%	8,239	9.1	5.7	4.1	17	1.0%
4	ZTE	1,911	8.2%	1,377	8.0%	4,462	3.1%	2,693	10.4	2.3	1.4	<b>365</b>	<b>21.2%</b>
5	Nokia	1,851	8.0%	1,028	6.0%	9,132	6.4%	6,995	7.3	4.9	3.8	87	5.0%
6	LGE	<b>1,771</b>	<b>7.6%</b>	1,602	9.3%	11,845	8.3%	9,106	9.9	6.7	5.1	69	4.0%
7	Datang Telecom	1,252	5.4%	1,158	6.7%	2,641	1.8%	1,927	11.0	2.1	1.5	6	0.3%
8	Ericsson	1,104	4.8%	756	4.4%	8,446	5.9%	5,550	9.5	7.7	5.0	0	
9	NTT	818	3.5%	706	4.1%	4,295	3.0%	3,056	9.2	5.3	3.7	48	2.8%
10	Interdigital	812	3.5%	501	2.9%	8,099	5.6%	5,370	7.6	10.0	6.6	112	6.5%
11	Sharp	763	3.3%	718	4.2%	3,706	2.6%	2,493	11.0	4.9	3.3	<b>293</b>	<b>17.0%</b>
12	Apple	449	1.9%	375	2.2%	6,191	4.3%	4,757	10.2	13.8	10.6	0	
13	ETRI	447	1.9%	423	2.5%	1,166	0.8%	988	8.5	2.6	2.2	0	
14	Alphabet	421	1.8%	311	1.8%	2,030	1.4%	1,763	6.6	4.8	4.2	0	
15	NEC	363	1.6%	221	1.3%	3,732	2.6%	2,640	9.8	10.3	7.3	118	6.8%
16	Fujitsu	359	1.5%	342	2.0%	1,655	1.2%	1,396	8.2	4.6	3.9	0	
17	Xiaomi	265	1.1%	227	1.3%	677	0.5%	242	10.5	2.6	0.9	80	4.6%
18	Kyocera	253	1.1%	252	1.5%	696	0.5%	624	12.4	2.8	2.5	0	
19	BBK Electronics	239	1.0%	210	1.2%	1,180	0.8%	767	9.9	4.9	3.2	0	
20	Blackberry	236	1.0%	107	0.6%	2,282	1.6%	1,834	7.8	9.7	7.8	8	0.5%
21	Others	2,951	12.7%	2,093	12.2%	22,351	15.6%	16,914	9.3	7.6	5.7	330	19.1%
	<b>Grand Total</b>	<b>23,232</b>	<b>100.0%</b>	<b>17,226</b>	<b>100.0%</b>	<b>143,431</b>	<b>100.0%</b>	<b>101,329</b>	<b>9.0</b>	<b>6.2</b>	<b>4.4</b>	<b>1,724</b>	<b>100%</b>

# 4G Stack: Coverage of Key Geographic Regions

Among Families declared to 4G, the Core Global grouping includes the most Families, Assets and new declarations. Huawei leads total 4G Family counts in geographic regions except Fast Growth, and concentration of Assets among top 20 owners is slightly less at sub-90% in all regions. Again, Fast Growth regions should be a focus because of licensing practices and other factors.

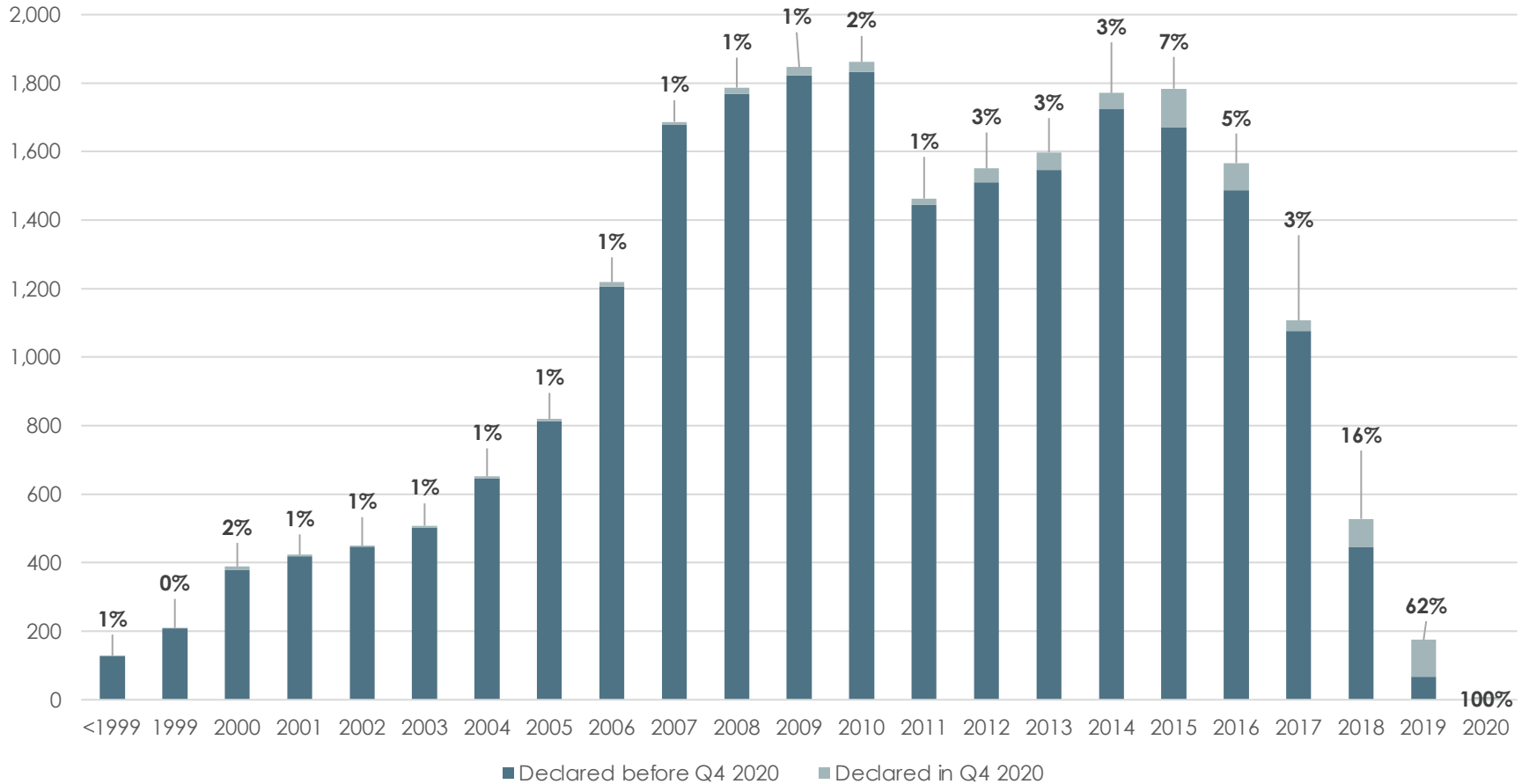
#	Patent Owner	Core Global			Core EP			Core Asia			Fast Growth		
		# of Families	# of Assets	New Declarations	# of Families	# of Assets	New Declarations	# of Families	# of Assets	% of New Declarations	# of Families	# of Assets	New Declarations
1	Huawei	<b>2,848</b>	9,171		<b>1,795</b>	2,417		<b>2,727</b>	5,109		766	1,034	
2	Qualcomm	1,897	8,277	5.4%	1,551	2,546	9.8%	1,855	8,764	6.3%	<b>1,525</b>	2,960	25.0%
3	Samsung	1,942	7,014	1.1%	1,335	1,912	1.1%	1,656	4,200	0.6%	642	807	
4	ZTE	1,873	3,335	24.9%	672	696	19.6%	1,819	2,301	23.6%	158	202	5.8%
5	Nokia	1,757	4,752	6.8%	1,366	1,646	8.7%	1,290	2,804	4.3%	642	819	1.9%
6	LGE	1,650	7,340	3.8%	1,010	1,678	4.5%	1,278	4,356	4.0%	362	593	
7	Datang Telecom	1,248	2,067	0.4%	396	407		1,232	1,707	0.6%	62	62	
8	Ericsson	1,009	3,914		890	1,323		794	1,731		607	853	
9	NTT	636	1,846	2.3%	473	556	2.5%	776	1,675	2.9%	352	474	
10	Interdigital	604	2,861	4.9%	392	653	4.9%	733	3,694	8.6%	274	508	5.8%
11	Sharp	692	2,265	20.1%	546	603	21.3%	738	1,533	9.2%	158	211	36.5%
12	Apple	428	3,607		197	761		240	1,961		74	307	
13	ETRI	297	635		76	121		364	549		5	13	
14	Alphabet	401	1,034		202	279		277	712		152	211	
15	NEC	318	1,851	6.6%	260	503	5.9%	337	1,583	9.0%	114	219	11.5%
16	Fujitsu	193	789		115	196		305	704		60	87	
17	Xiaomi	265	464	4.5%	70	89		241	287	6.5%	28	37	
18	Kyocera	185	371		58	77		224	332		1	1	
19	BBK Electronics	239	680		134	220		114	215		45	85	
20	Blackberry	225	1,233	0.7%	180	407	1.4%	158	553	0.2%	95	142	
21	Others	2,645	11,722	18.5%	1,769	3,103	20.3%	2,396	7,938	24.2%	787	1,389	13.5%
	<b>TOTAL (# not %)</b>	<b>21,352</b>	<b>75,228</b>	<b>1,054</b>	<b>13,487</b>	<b>20,193</b>	<b>286</b>	<b>19,554</b>	<b>52,708</b>	<b>631</b>	<b>6,909</b>	<b>11,014</b>	<b>52</b>

# 4G Stack: Priority Dates Breakdown

4G declared Families' priority is centered in 2006-2016 and Q4 2020 4G declarations remain strong in those years.

## Priority Dates

(Count of families)

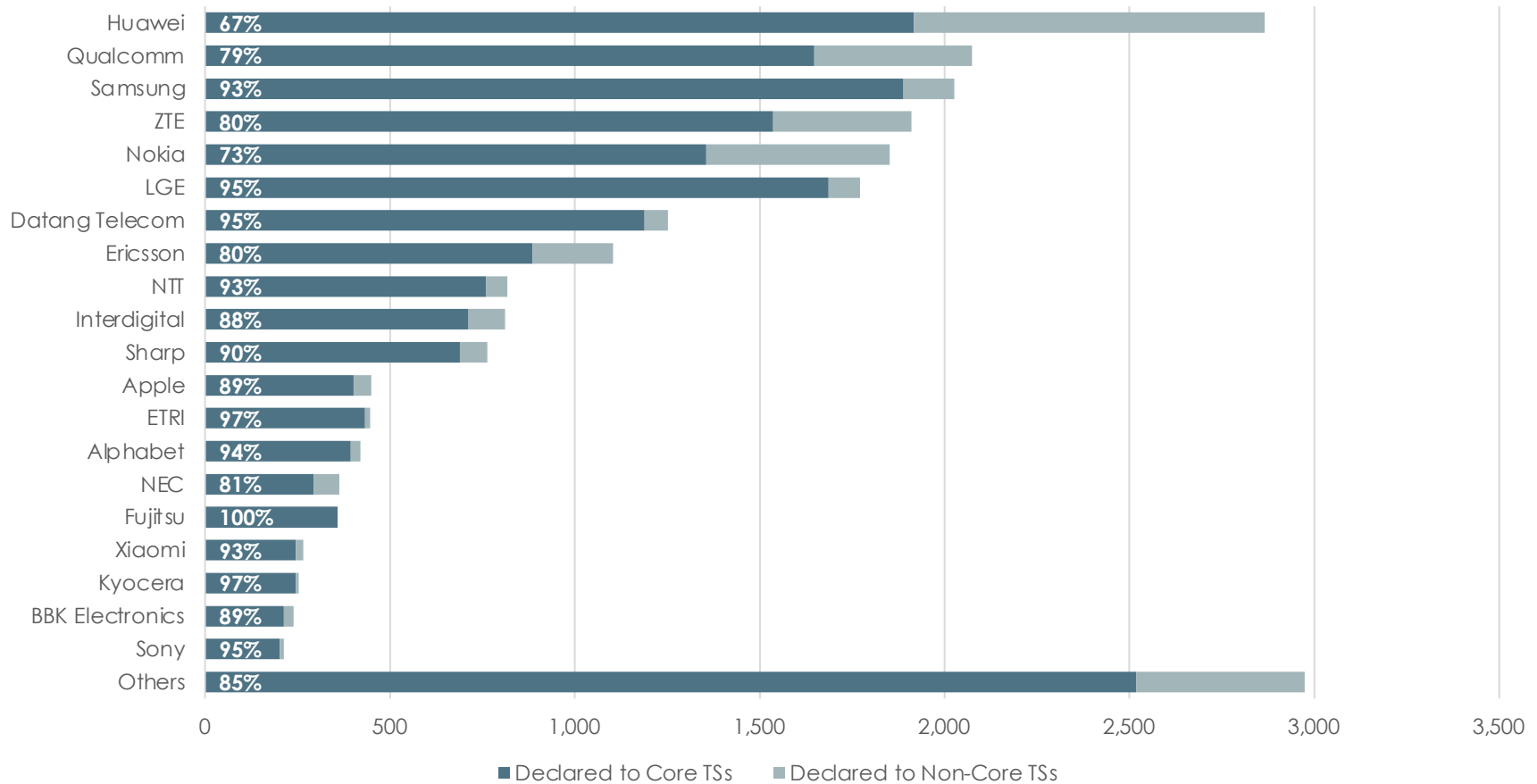


# 4G Stack Declared to Core TSs: Family Counts

Repeating the Tech+IP categorization based on TS driven by market realities, we identified 14% of all 4G TSs as core 4G TSs (see Appendix and the link below). 84% of the total 4G families are declared to core TSs.

## Company Overview

(Count of families)



(1) Tech+IP breakdown of TSs to Core Vs. Non-core: <https://app.box.com/file/763647358216>.

# 4G Stack: Technical Standards Per Priority Dates Breakdown

Most 4G Families have a priority year between 2007-2015. The most frequent TSs to which those families have been declared are 36.2xx and 36.3xx.

TS Number	TS Name	Priority Date								
		2007	2008	2009	2010	2011	2012	2013	2014	2015
TS 36.213	(E-UTRA); Physical layer procedures	14%	15%	16%	18%	17%	15%	14%	18%	20%
TS 36.331	(E-UTRA); Radio Resource Control (RRC); Protocol specification	13%	13%	15%	15%	15%	14%	14%	18%	18%
TS 36.211	(E-UTRA); Physical channels and modulation	14%	13%	13%	14%	13%	12%	10%	11%	13%
TS 36.300	(E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2	12%	12%	12%	12%	12%	11%	11%	12%	12%
TS 36.321	(E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2	9%	10%	10%	9%	9%	7%	8%	8%	9%
TS 36.212	(E-UTRA); Multiplexing and channel coding	9%	10%	9%	10%	7%	8%	8%	8%	9%
TS 25.331	Radio Resource Control (RRC); Protocol specification	4%	3%	2%	1%	2%	3%	3%	1%	0%
TS 23.401	General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access	1%	2%	1%	1%	2%	2%	2%	1%	1%
TS 25.321	Medium Access Control (MAC) protocol specification	3%	2%	1%	1%	1%	0%	0%	0%	0%
TS 36.304	Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) procedures in idle mode	1%	1%	1%	0%	1%	1%	1%	1%	2%

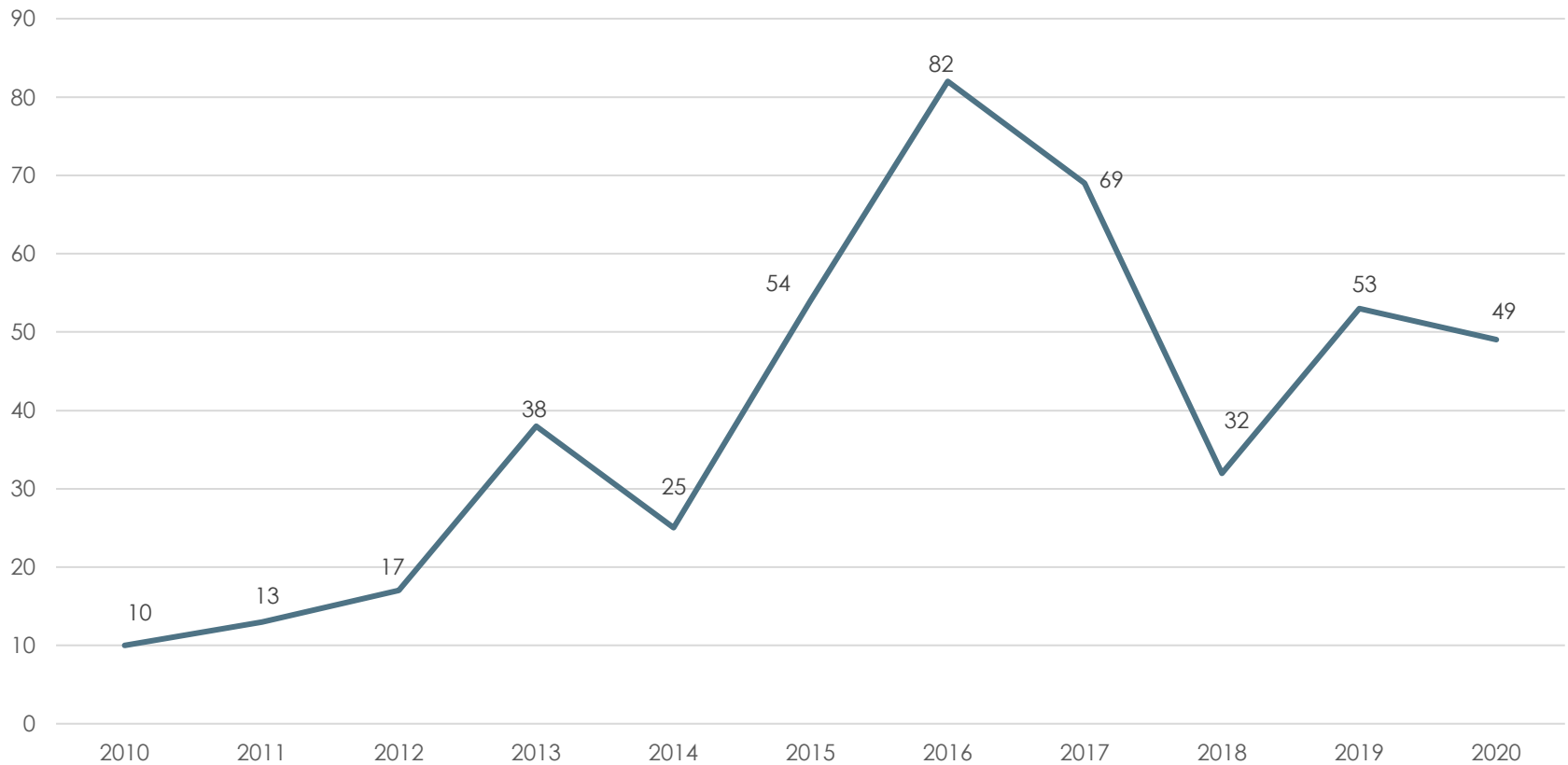
(1) There is a significant overlap in counts because families can be declared to multiple generations.

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# 4G-5G SEP Patent Lawsuits Filed 2010-2020

SEP lawsuits matter; 4G-5G SEP suits grew steadily over the last decade with a peak in 2016. The number of 4G-5G SEP suits does not appear to correlate with the overall number of patent suits filed (see Appendix).

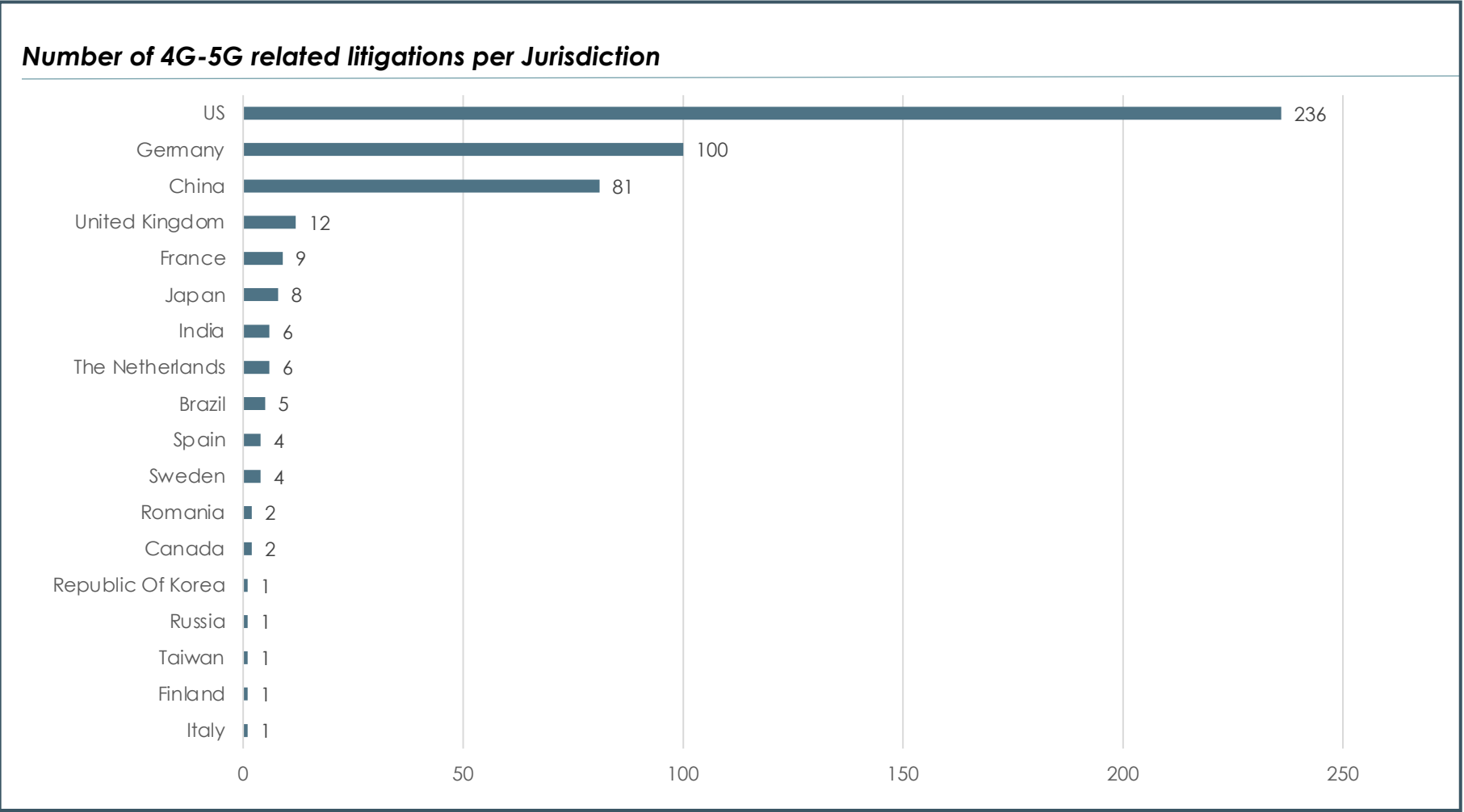
**Number of litigations per year**



(1) Sources: Lex Machina and Darts IP

# Jurisdiction Breakdown

The US used to be the overwhelmingly most frequent jurisdiction for 4G-5G SEP patent litigation – accounting for more litigation than all other jurisdictions combined. Now, the US represents slightly fewer cases than the rest of the world combined (236 to 244). The undeniable trend is toward more global enforcement.



(1) Sources: Lex Machina and Darts IP 2003-2020



## 20 Most Litigated 4G-5G Relevant SEPs | US

Based on the previously articulated thesis that not all TS's are equal, Tech+IP is tracking reported litigations also based on TS. The most litigated patents relevant to 4G-5G in the US are declared to TSs 36.300 and 25.300. NPE's continue to be a driver of litigation in this technical field.

### Patents involved in Judicial Proceedings

Current Patent Owner	Patent Number	TS's	Number of Cases
<b>Nokia</b>	US8055820	TS 36.300   TS 23.100	18
<b>Nokia</b>	US7941174	TS 25.300	18
<b>Saint Lawrence Communications</b>	US7260521	TS 26.100	16
<b>Saint Lawrence Communications</b>	US7191123	TS 26.100   TS 26.200	16
<b>Saint Lawrence Communications</b>	US6795805	TS 26.100	16
<b>Intellectual Ventures</b>	US7787431	TS 36.300   TS 36.200	16
<b>Saint Lawrence Communications</b>	US6807524	TS 26.100	16
<b>Saint Lawrence Communications</b>	US7151802	TS 26.100	16
<b>Intellectual Ventures</b>	US8396079	TS 36.300   TS 36.200   TS 36.100	15
<b>Intellectual Ventures</b>	US7848353	TS 36.300   TS 36.200   TS 36.100	15
<b>Cellular Communications Equipment</b>	US6819923	TS 04.60	15
<b>Sisvel</b>	US8971279	TS 36.300   TS 36.200	13
<b>Sisvel</b>	US7869396	TS 38.300   TS 38.200   TS 36.300   TS 36.200   TS 25.300   TS 25.200	13
<b>Nokia</b>	US6810019	TS 38.300   TS 25.300	13
<b>3G Licensing</b>	US8600383	TS 36.300   TS 25.300   TS 23.100   TS 21.900	12
<b>3G Licensing</b>	US8189611	TS 24.300	12
<b>Sisvel</b>	US7979070	TS 36.300   TS 23.400	12
<b>3G Licensing</b>	US7551625	TS 25.300   TS 25.300	12
<b>3G Licensing</b>	US7580388	TS 25.300	12
<b>3G Licensing</b>	US7215653	TS 25.300   TS 25.200	12
			<b>288</b>

(1) Sources: Lex Machina and Darts IP

## 20 Most Litigated 4G-5G Relevant SEPs | Non-US Jurisdictions

The most litigated patents outside the US are declared to TSs 36.300 and 36.200. Unlike in the US, most of the litigated patents in other jurisdictions are owned by operating companies.

### Patents involved in Judicial Proceedings

Current Patent Owner	Patent Number	TS's	Number of Cases
<b>Samsung</b>	EP1188269	TS 38.300   TS 38.200   TS 36.300   TS 36.200   TS 25.400   TS 25.300   TS 25.200	8
<b>Ericsson</b>	IN234157	Blanket Declaration (GSM)	6
<b>Marathon Patent Group</b>	EP1125463	TS 25.300   TS 25.200	6
<b>Ericsson</b>	IN203034	Blanket Declaration (GSM)	6
<b>Ericsson</b>	IN203036	TS 26.000	6
<b>Ericsson</b>	IN203686	Blanket Declaration (GSM)	6
<b>Ericsson</b>	IN213723	Blanket Declaration (GSM)	6
<b>Marathon Patent Group</b>	EP1326469	TS 21.200   TS 33.100	6
<b>Marathon Patent Group</b>	EP1400077	TS 23.000   TS 23.200   TS 29.100	6
<b>Marathon Patent Group</b>	EP1326470	TS 21.200   TS 33.100	6
<b>Unwired Planet</b>	EP2119287	TS 36.300	5
<b>Ericsson</b>	IN229632	TS 36.300   TS 36.200	5
<b>Unwired Planet</b>	EP2485514	TS 36.300	5
<b>Ericsson</b>	EP1058927	TS 26.000	5
<b>Ericsson</b>	IN240471	TS 36.300	5
<b>Ericsson</b>	IN241747	TS 36.200	5
<b>Samsung</b>	EP1114528	TS 38.300   TS 38.200   TS 36.300   TS 36.200   TS 25.200	4
<b>Ericsson</b>	EP1952560	TS 38.200   TS 36.200	4
<b>Conversant</b>	EP1878177	TS 36.300   TS 25.300   TS 25.200	4
<b>Unwired Planet</b>	EP1230818	TS 45.008	3
			<b>107</b>

(1) Sources: Lex Machina and Darts IP

# Counter Lawsuits Are Strategically Significant in SEP Litigation

In the United States (and increasingly in other jurisdictions) countersuits are an important tactic in 4G-5G SEP litigation where the patent owner makes products. This has led to a variety of transactions. Examples include:

Filed On	Case	Court	Accused Products	Outcome
2018-10-24	L3Harris Technologies v. Huawei	E.D.Tex.	Enterprise networking equipment and solutions	Settlement
2019-07-12	Huawei v. L3Harris Technologies	D.Del.	LTE mobile communication systems	Settlement

2019-08-28	InterDigital Technology Corp et al v. Lenovo	D.Del. and UK High Ct	Wireless devices (smartphones and other cellular-enabled devices) Infringement and FRAND dispute	Ongoing
2020-04-13	Lenovo et al v. InterDigital Technology Corp	D.Del.	Cellular standards FRAND dispute	Ongoing

2014-11-18	Saint Lawrence Communications v. LG Electronics	E.D.Tex.	HD Voice in wireless communication	Settlement
2018-11-28	LG Electronics v. Saint Lawrence Communications	S.D.N.Y.	Breach of licensing agreement entered into to settle litigation from 2014	Settlement

2014-11-18	TCL Communication Technology v. Ericsson	C.D.Cal.	Cellular standards FRAND dispute	Plaintiff Won
2018-11-28	Ericsson v. TCL Communication Technology	E.D.Tex.	Cellular standards Infringement	Plaintiff Won

2015-01-23	Sonus Networks, Inc. v. Inventergy, Inc.	N.D.Cal.	Declaratory Judgement action, Communication systems	Settlement
2015-01-26	Inventergy Inc. v. Sonus Networks, Inc.	D.Mass.	Infringement action, Communication systems	Settlement

(1) Source: Lex Machina

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# Definitions and Methodology for Patent & Declaration Data (1 of 2)

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- Patent data is derived from the Innography ® database and follows the industry-standard Innography **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 January 1, 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 January 1, 2021.
- **Core Global** includes the following jurisdictions: United States, China, EPO, Germany, France, Great Britain, Netherlands.
- **Core EP** includes the following jurisdictions: EPO, Germany, France, Great Britain, Netherlands.
- **Core Asia** includes the following jurisdictions: China, Japan, Taiwan, South Korea.
- **Fast Growth** includes the following jurisdictions: India, Brazil, Indonesia, Malaysia.
- **Core TSs for 4G:** Technical standard series 36 that are directed to elemental concepts for 4G existence. It also includes closely related series of Technical standards with initial release 8.
- **Core TSs for 5G:** Technical standard series 38 that address New Radio features and 5G Core standalone technologies. It also includes closely related series of Technical standards with initial release 15.
- **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.).

(1) ETSI Dynamic Report: <https://jpr.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 of 2)

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- **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”.
- **Single Generation (Single XG):** According to 3GPP website<sup>(2)</sup>, the TS indicated in the appropriate Label is applicable to a single Generation.
- **Multi Generation (Multi XGs):** According to 3GPP website<sup>(3)</sup>, 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

(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>

# 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, Albania, 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, Viet Nam, 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 granted patents and does not include published applications for the following jurisdictions (all are listed in the ETSI database): Belgium, Cyprus, Algeria, Egypt, Georgia, Jordan, Luxembourg, Malaysia, Saudi Arabia, Slovenia and South Africa
- Innography data includes only EP grants filed through European Patent Office (EPO) and does not include nationalized EP grants

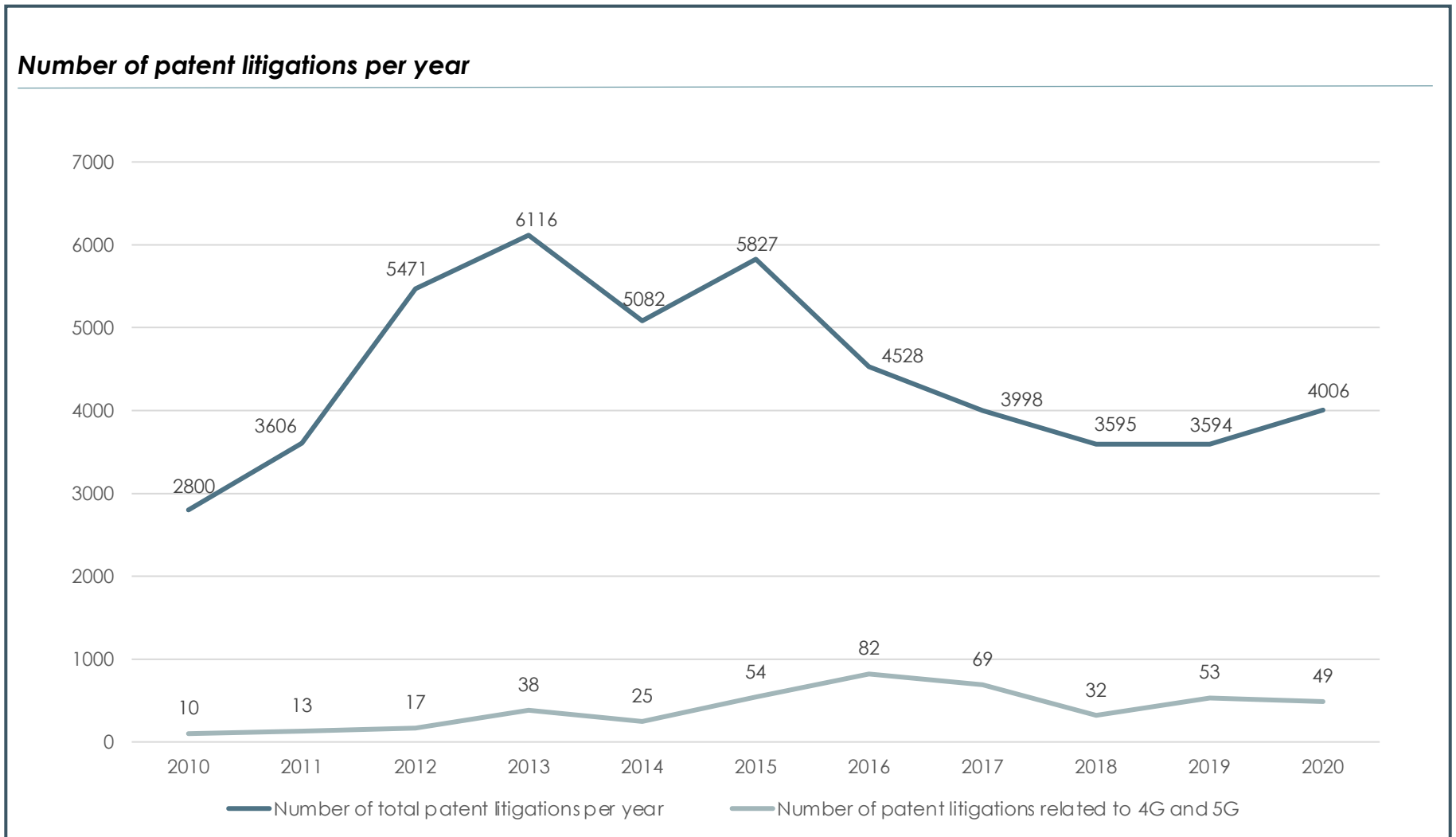
## • LexMachina Limitations

- 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

# Comparison of ETSI 4G-5G SEP and All Patent Lawsuits 2010-2020



(1) Sources: Lex Machina and Darts IP

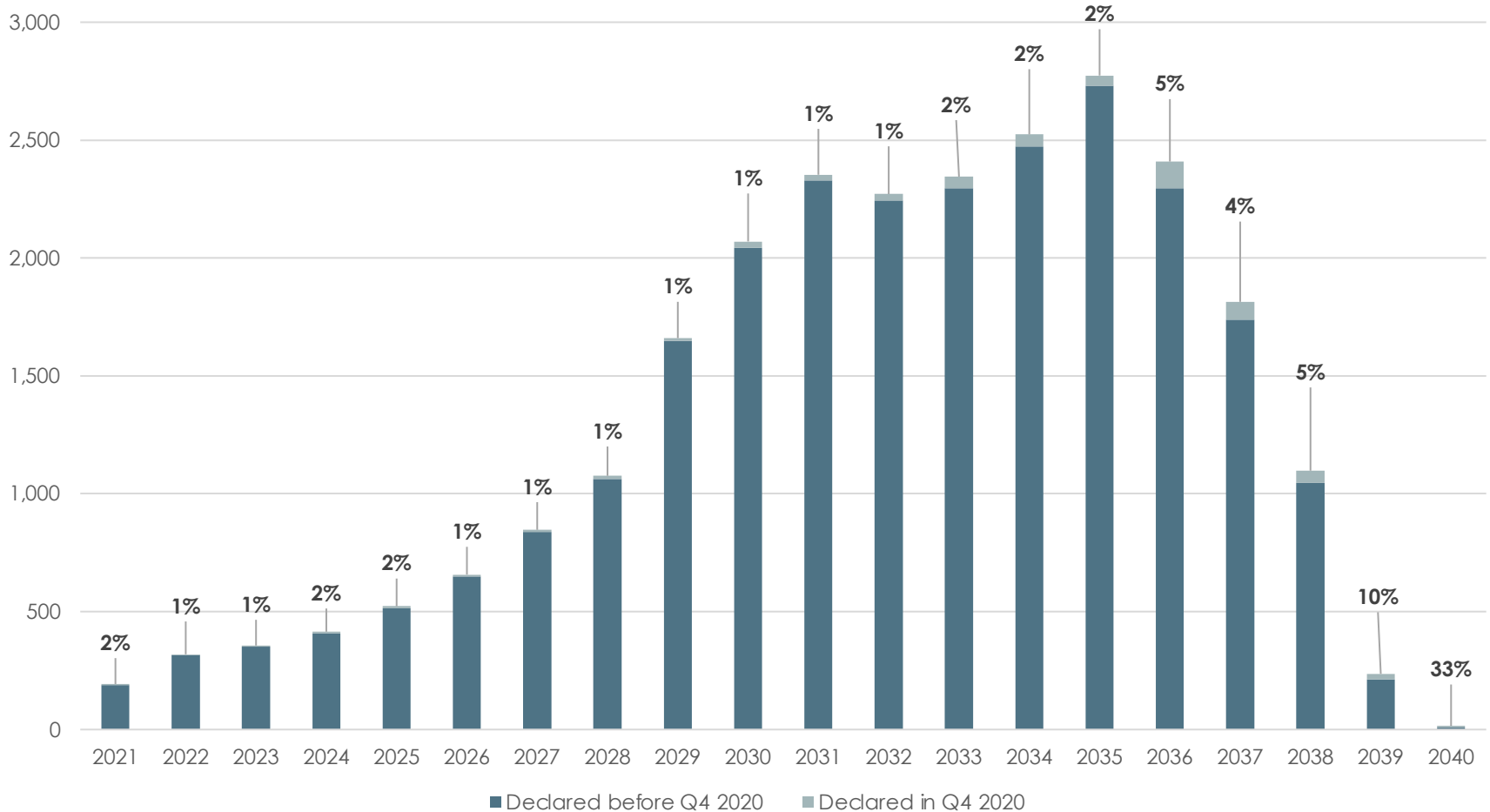


# 4G-5G Comprehensive Stack: Expiration Dates Breakdown

Only 31% of families declared to 4G-5G stack will expire before 2030.

## Expiration Dates

(Count of families with granted patents)

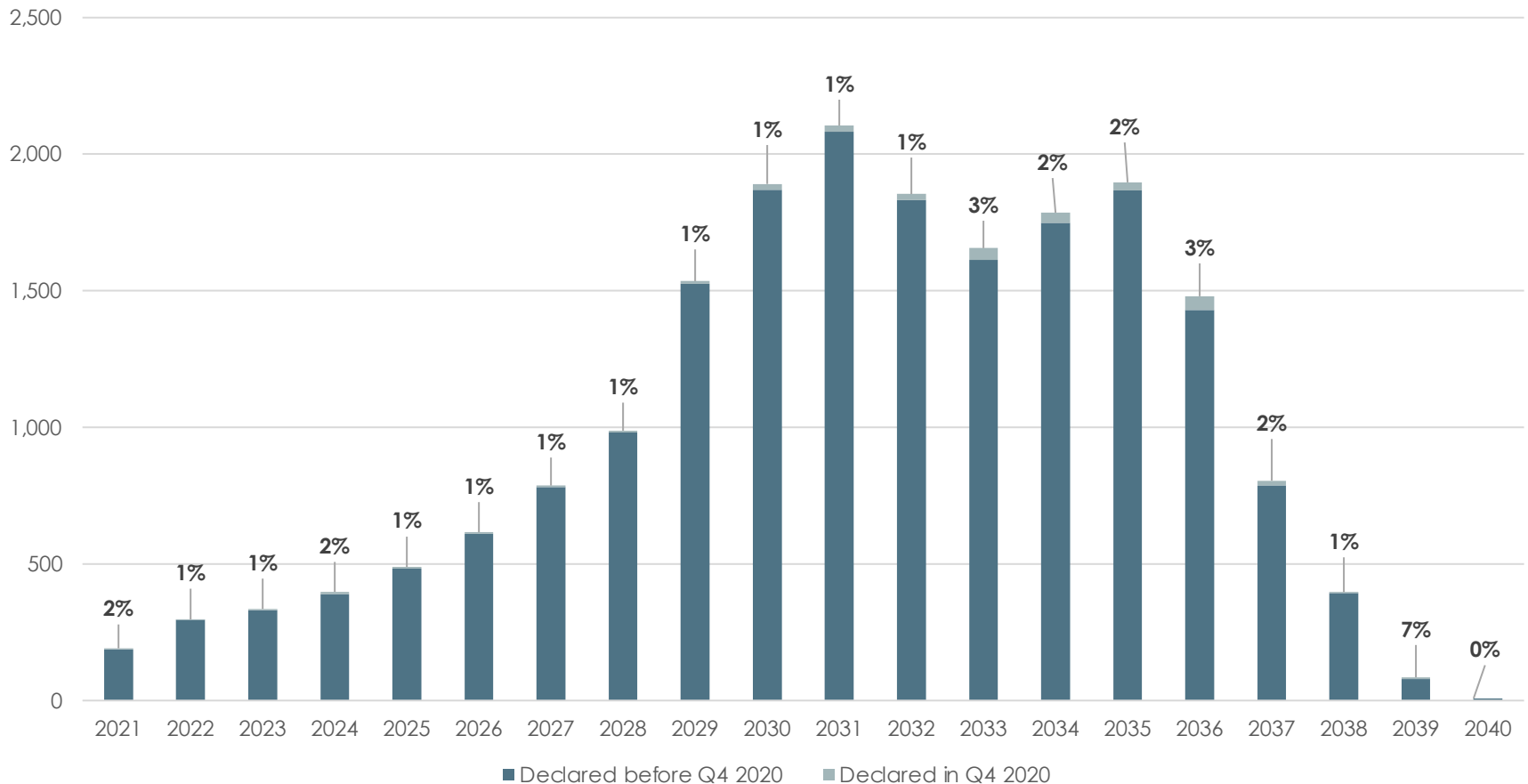


# 4G Stack: Expiration Dates Breakdown

Almost 62% of families declared to 4G will be active after 2030, and 14% of said families will remain active after 2035.

## Expiration Dates

(Count of families with granted patents)

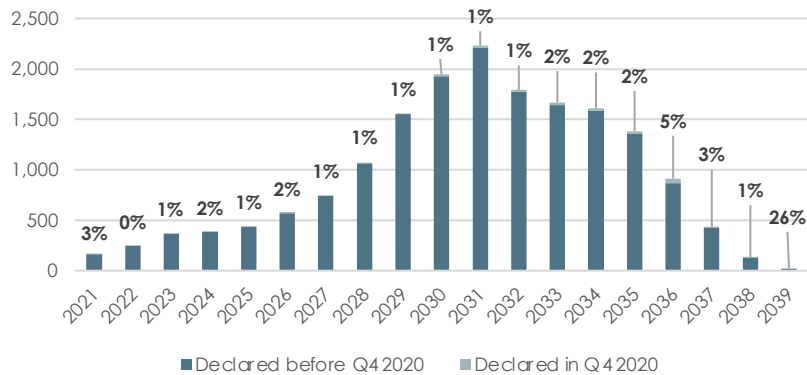


# 4G Stack: Expiration Dates Breakdown per Core Geographic Coverages

A significant difference can be noted between expiration profiles of different geographic coverages. Whereas highest number of families in Core Global and Core Asia expire between 2029-2035 (69% and 61% respectively), in Core EP that is between 2028-2034 (62%) and in Fast Growth between 2025-2030 (71%).

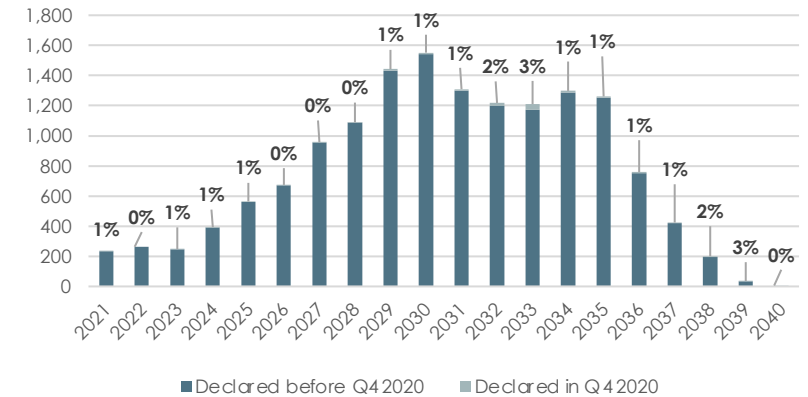
## Core Global Expiration Profile

(Count of families with granted patents)



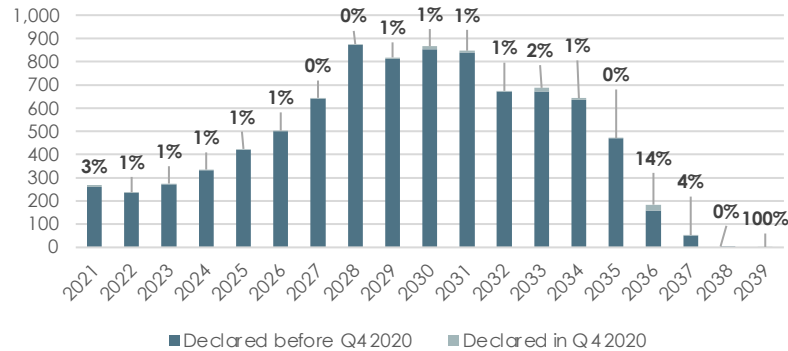
## Core Asia Expiration Profile

(Count of families with granted patents)



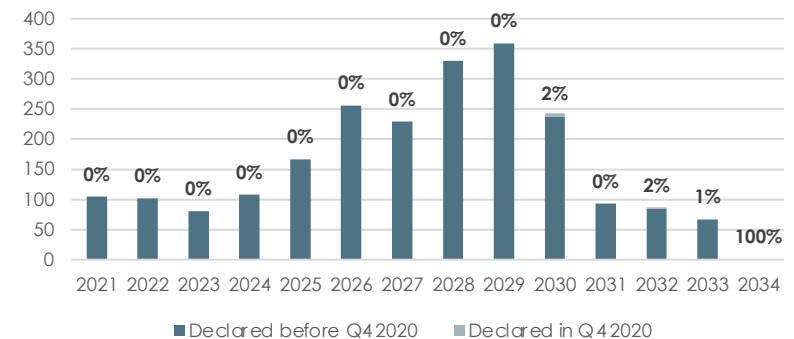
## Core EP Expiration Profile

(Count of families with granted patents)



## Fast Growth Expiration Profile

(Count of families with granted patents)



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

The tables below provide TS information on 4G patent families and granted patents. 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)		12,232	52.7%
Single Generation (Single XG)		10,695	46.0%
Declared to ETSI Project only		305	1.3%
<b>Total</b>		<b>23,232</b>	<b>100%</b>
Top 5 TS Declarations	TS Name	# of Families <sup>(1)</sup>	% of Families
TS 36.331	E-UTRA; RRC; Protocol specification	12,966	58%
TS 36.213	E-UTRA; Physical layer procedures	12,830	57%
TS 36.211	E-UTRA; Physical channels and modulation	11,907	53%
TS 36.300	E-UTRA and E-UTRAN; Overall description; Stage 2	11,097	49%
TS 36.212	(E-UTRA); Multiplexing and channel coding	9,468	42%

## Granted Patents

SEP Status		# of Granted Patents	% of Granted Patents
Multi Generation (Multi XGs)		58,336	57.6%
Single Generation (Single XG)		38,228	37.7%
Potential SEP		4,016	4.0%
Declared to ETSI Project only		749	0.7%
<b>Total</b>		<b>101,329</b>	<b>100%</b>
Top 5 TS Declarations	TS Name	# of Granted Patents <sup>(1)</sup>	% of Granted Patents
TS 36.213	(E-UTRA); Physical layer procedures	48,079	49%
TS 36.331	(E-UTRA); Radio Resource Control (RRC); Protocol specification	42,374	44%
TS 36.211	(E-UTRA); Physical channels and modulation	41,407	43%
TS 36.300	E-UTRA and E-UTRAN; Overall description; Stage 2	37,209	38%
TS 36.212	(E-UTRA); Multiplexing and channel coding	28,748	30%

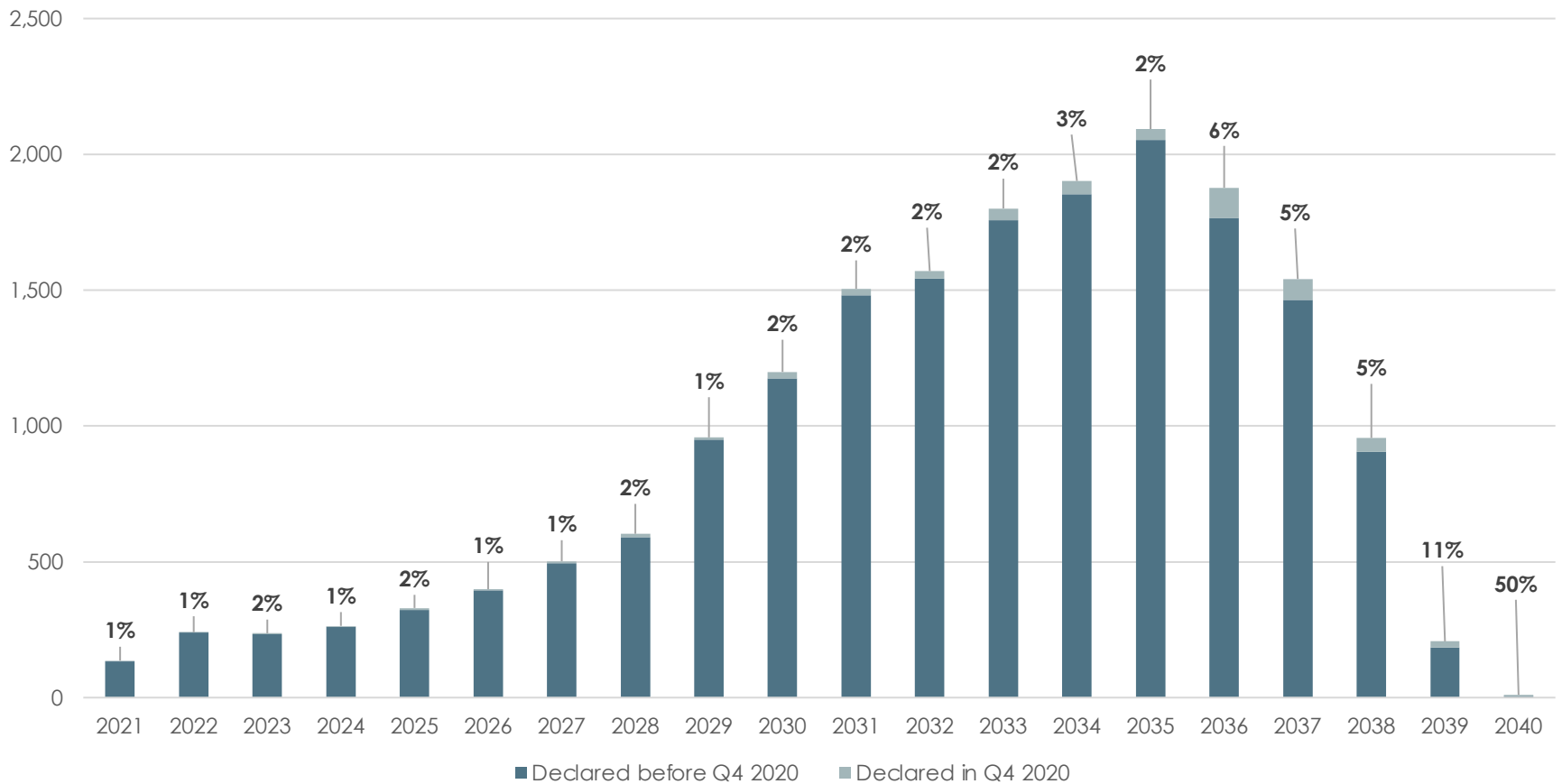
(1) There is a significant overlap in counts because families and assets can be declared to multiple generations.

# 5G Stack: Expiration Dates Breakdown

Only 25% of families declared to 5G stack will expire before 2030.

## Expiration Dates

(Count of families with granted patents)

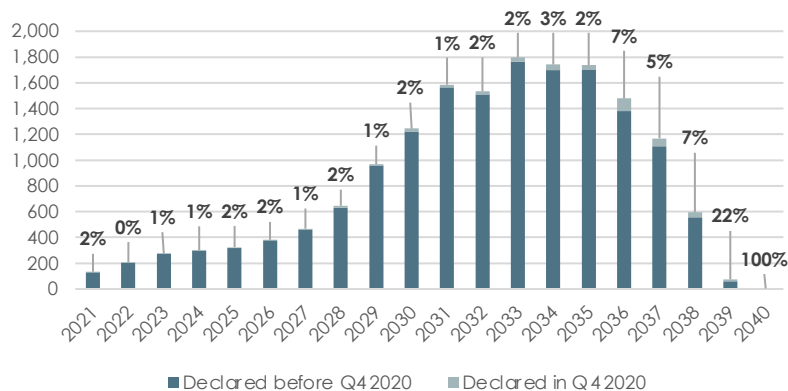


# 5G Stack: Expiration Dates Breakdown per Geographic Coverages

A significant difference appears to exist between Fast Growth area expiration profiles (65% of families expiring between 2026-2030) and the Core Global, Core Asia and Core EP areas, where the highest number of families expire roughly five years later (between 2031-2036; 60%, 54% and 47% respectively).

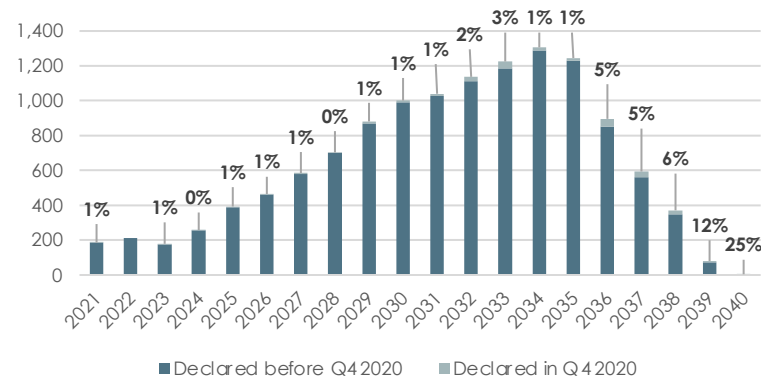
## Core Global Expiration Profile

(Count of families with granted patents)



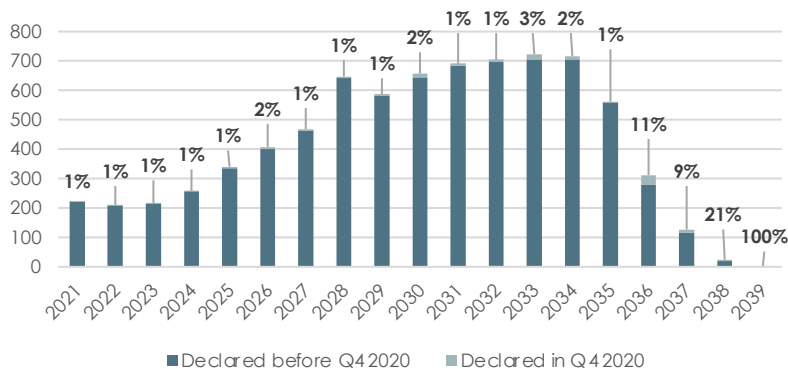
## Core Asia Expiration Profile

(Count of families with granted patents)



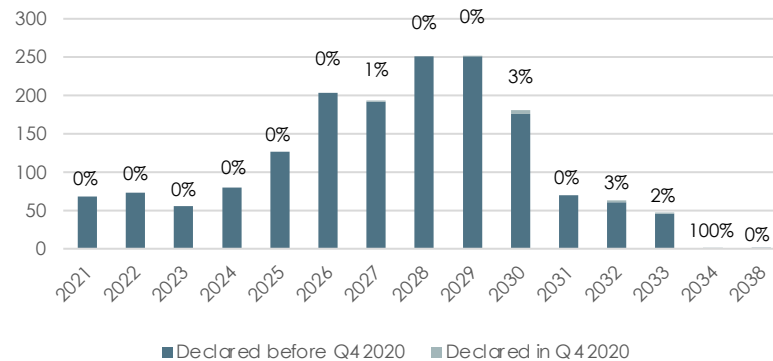
## Core EP Expiration Profile

(Count of families with granted patents)



## Fast Growth Expiration Profile

(Count of families with granted patents)



# 5G Stack: Specification Breakdown (Families and Granted Patents)

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 granted patent counts are 36 and the rest are 38.

## Families

SEP Status		# of Families	% of Families
Single Generation (Single XG)		18,567	60.2%
Multi Generation (Multi XGs)		12,232	39.7%
Declared to ETSI Project only		35	0.1%
<b>Total</b>		<b>30,834</b>	<b>100%</b>

Top 5 TS Declarations	TS Name	# of Families <sup>(1)</sup>	% of Families
TS 38.331	(E-UTRA); Physical layer procedures	14,393	49%
TS 38.213	NR; Physical layer procedures for control	14,197	49%
TS 38.211	NR; (RRC); Protocol specification	12,200	42%
TS 38.214	(E-UTRA);(RRC); Protocol specification	11,790	40%
TS 38.212	NR; Physical channels and modulation	11,555	40%

## Granted Patents

SEP Status		# of Granted Patents	% of Granted Patents
Multi Generation (Multi XGs)		58,336	69.7%
Single Generation (Single XG)		21,429	25.6%
Potential SEP		3,761	4.5%
Declared to ETSI Project only		129	0.2%
<b>Total</b>		<b>76,162</b>	<b>100%</b>

Top 5 TS Declarations	TS Name	# of Granted Patents <sup>(1)</sup>	% of Granted Patents
TS 38.213	NR; Physical layer procedures for control	29,779	37%
TS 38.331	(E-UTRA); Physical layer procedures	27,198	34%
TS 38.211	NR; (RRC); Protocol specification	25,062	31%
TS 38.214	(E-UTRA);(RRC); Protocol specification	24,280	30%
TS 38.212	NR; Physical channels and modulation	18,887	24%

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



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