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Statistical Bias and Variability in Sampling and Assessing Patents' Standard-Essentiality

Top-down SEP valuation methodologies that rely on any patent counting—with or without essentiality checking—are deeply flawed. It should not be construed that this research and presentation advocates use of these techniques. However, if they are to be used at all—let alone institutionalized and prescribed by the authorities—various deficiencies should be recognized, quantified and mitigated in study designs.

Keith Mallinson
Founder, WiseHarbor

Why Count and Who Counts SEPs?

- **Despite being antithetical to patent law**
  - Ignoring validity
  - Assumes all patent counts are proportionate to value
- **To (simplistically) set royalty rates "top-down"**
  - Denominator: total count of patents deemed to be SEPs
  - Numerator: count of licensor's patents deemed to be SEPs
  - Licensor's royalty rate = aggregate rate x numerator/denominator
- **To "unpack" cross-licenses in deriving one-way rates in comparable license analysis**
  - Ratio of patent counts for two companies are used to calculate the patent *Portfolio Strength Ratio* used in an unpacking formula
- **In *Unwired Planet*, Justice Birss said:**
  - "In assessing a FRAND rate counting patents is inevitable"
  - He used a top-down valuation method as a "cross-check" to comparable license analysis employing license unpacking

What should be Counted?

- **Apple's "Statement on FRAND Licensing of SEPs" states:**
  - "A SEP licensor's *pro rata* share of declared SEPs is an objective reference point in a FRAND negotiation"
- **But there is widespread concern about over-declaration**
  - Not all declared-essential patents are truly essential
  - Requirement is to declare patents that might be essential
  - Strong incentives and limited constraints on over-declaring
  - OEMs do not want to pay for numerous non-asserted patents
  - Licensors with strong SEP positions diluted by inflated SEP counts
- **Consensus is only to count deemed-essential patents, if patent counting at all**
- **But there are too many declared-essential patents**
  - To essentiality check all these (e.g. >150,000 for 5G already)
  - So, patent sampling is proposed to enable thorough assessments taking days per patent actually assessed

How do we Count SEPs Accurately and Reliably?

- **Uncertainties abound with wide ranging opinions on:**
  - Proportion of all declared essential patents that are truly essential
  - Let alone, what proportions of these are owned by whom?
  - Determinations reflect widespread differences of opinion

- **Empirical research quantifying (in)accuracies in essentiality assessments and patent counts**
  1. Wildly different results among assessors reflect their partialities
  2. **Statistical bias with imperfect essentiality assessments**
  3. **Variability through sampling**

- **Comparing assessors' essentiality determinations in litigation and in various studies can be used to estimate**
  - Ranges in likely true essentiality rates
  - Ranges in likely accuracy rates in essentiality assessment

- **Mathematical modeling and simulations can guide fit-for-purpose essentiality study designs**

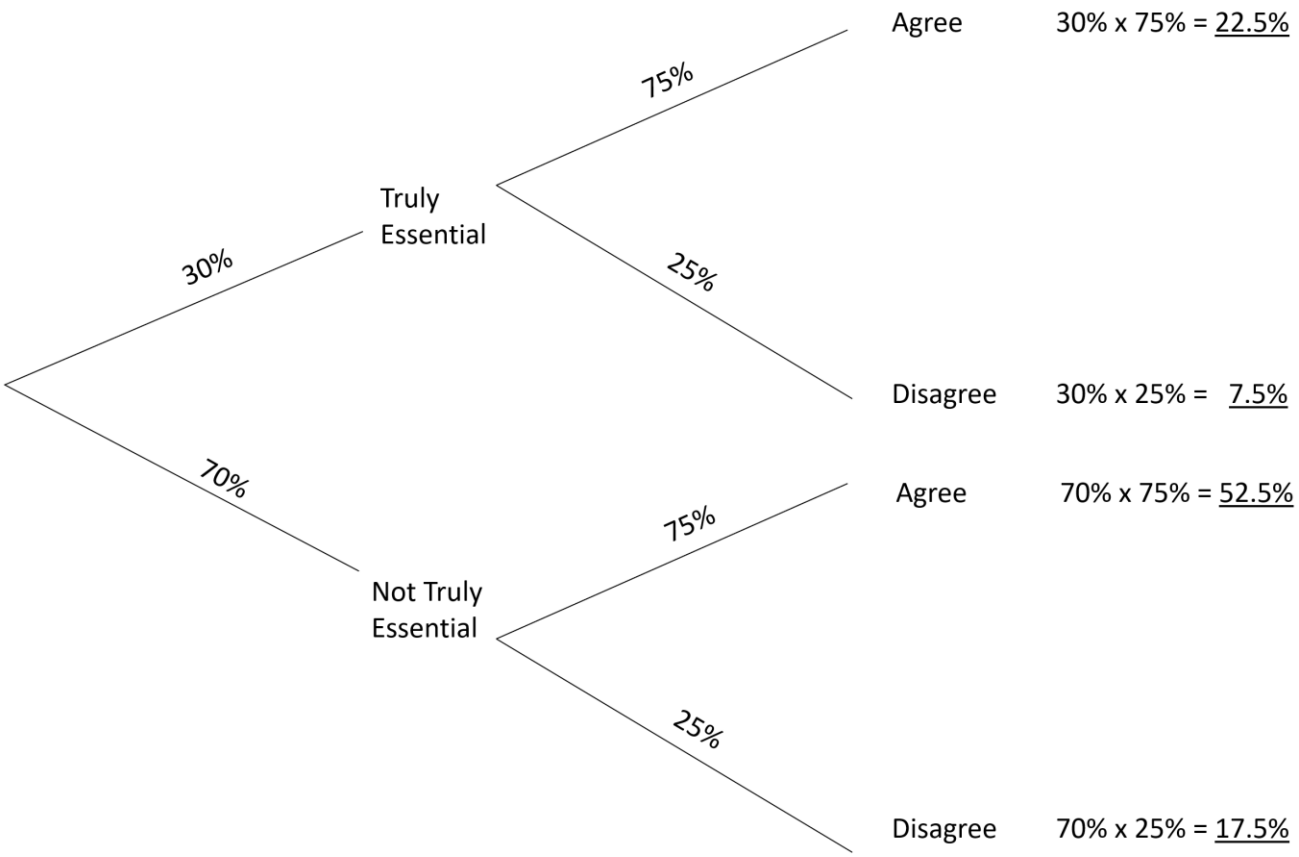
"Transparency" in Inaccurate Measurements like These Does more Harm than Good

	Cyber 1 (2011)	Cyber 2 (2012)	Cyber 3 (2013)	Article One (2012)	Jefferies (2011)	iRunway	Fairfield 2010	ABI Research 2009	Dr Ding TCL v. Ericsson (2016)
Cyber 1 (2011)	1.000	0.868	0.817	0.203	0.285	0.654	0.077	0.666	0.509
Cyber 2 (2012)		1.000	0.947	0.127	0.276	0.677	0.170	0.541	0.522
Cyber 3 (2013)			1.000	0.222	0.340	0.577	0.081	0.628	0.617
Article One (2012)				1.000	0.278	0.265	0.286	0.375	0.811
Jefferies (2011)					1.000	0.305	0.001	0.407	0.568
iRunway (2012)						1.000	0.004	0.387	0.634
Fairfield 2010							1.000	0.004	0.147
ABI Research 2009								1.000	0.564
Dr Ding TCL v. Ericsson (2016)									1.000

- **Weak correlations among studies' results in linear regression between companies' 4G LTE SEP counts**
- **Extremely different SEP share determinations: Lowest Estimate, Highest Estimate, Disparity**
  - Huawei: 2.9%, 23%, 8x
  - LG: 0.6%, 17%, 17x
  - Nokia: 2.3%, 54%, 23x
- **See: <u>Do not Count on Accuracy in Third-Party Patent-Essentiality Determinations</u>, WiseHarbor, May 2017**

Colour Coding of R^2 Co-Efficients			
R^2 Colour	Less Than or equal to	More Than	Colour Range
	1.0000	0.9000	0.1000
	0.9000	0.8000	0.1000
	0.8000	0.7000	0.1000
	0.7000	0.6000	0.1000
	0.6000	0.5000	0.1000
	0.5000	0.4000	0.1000
	0.4000	0.3000	0.1000
	0.3000	0.2000	0.1000
	0.2000	0.1000	0.1000
	0.1000	0.0000	0.1000

Statistical Bias in Imperfect Essentiality Determination—Example



- **Truly essential: 30%**
- **Found essential: 22.5%+17.5%=40%**
- **Found not essential: 7.5%+52.5%=60%**

Look-up Table of Found Essentiality Rates Reflecting Bias due to Imperfect Determinations

True Essentiality Rate

Accuracy Rate	0%	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%
50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
55%	45%	46%	46%	47%	47%	48%	48%	49%	49%	50%	50%
60%	40%	41%	42%	43%	44%	45%	46%	47%	48%	49%	50%
65%	35%	36%	38%	39%	41%	42%	44%	45%	47%	48%	50%
70%	30%	32%	34%	36%	38%	40%	42%	44%	46%	48%	50%
75%	25%	27%	30%	32%	35%	37%	40%	42%	45%	47%	50%
80%	20%	23%	26%	29%	32%	35%	38%	41%	44%	47%	50%
85%	15%	18%	22%	25%	29%	32%	36%	39%	43%	46%	50%
90%	10%	14%	18%	22%	26%	30%	34%	38%	42%	46%	50%
95%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%
100%	0%	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%

- **True Essentiality Rate: # truly essential SEPs/total # declared SEPs**
- **Accuracy Rate = # correct determinations/total # determinations**
- **Accuracy Rate can be determined by comparing assessors' results**

Variability in Sampled Essentiality Rates…

- **Decreases with larger sample sizes**
- **Increases (proportionately) at lower essentiality rates**
- **Binomial theory formula: $\sigma=(E(1-E)/N)^{0.5}$**
- **95% Confidence Interval between ± 1.96 x σ**
- **Study examples:**

	Cooper 2019 LTE	Cooper et al 2021 5G	CRA 2016 hypothetical	CRA 2016 adjusted: 10x sample	Dr Ding Concur IP TCL v. Ericsson	EC Pilot 2020 experiment
Sample size N	200	200	30	300	2,600	205
Essentiality rate E	12%	8.0%	30%	30%	37.3%	30%
Standard deviation σ additive	2.30%	1.92%	8.37%	2.65%	0.95%	3.20%
1.96 x σ additive (95% confidence)	4.5%	3.76%	16.4%	5.2%	1.9%	6.3%
Lower bound, 95% C.I.	7.5%	4.2%	13.6%	24.8%	35.4%	23.7%
Higher bound, 95% C.I.	16.5%	11.8%	46.4%	35.2%	39.2%	36.3%
Higher/Lower 95% C.I.	2.20	2.77	3.41	1.42	1.10	1.53
1.96 x σ/E proportionate (95% confidence)	37.5%	47.0%	54.7%	17.3%	5.0%	20.9%

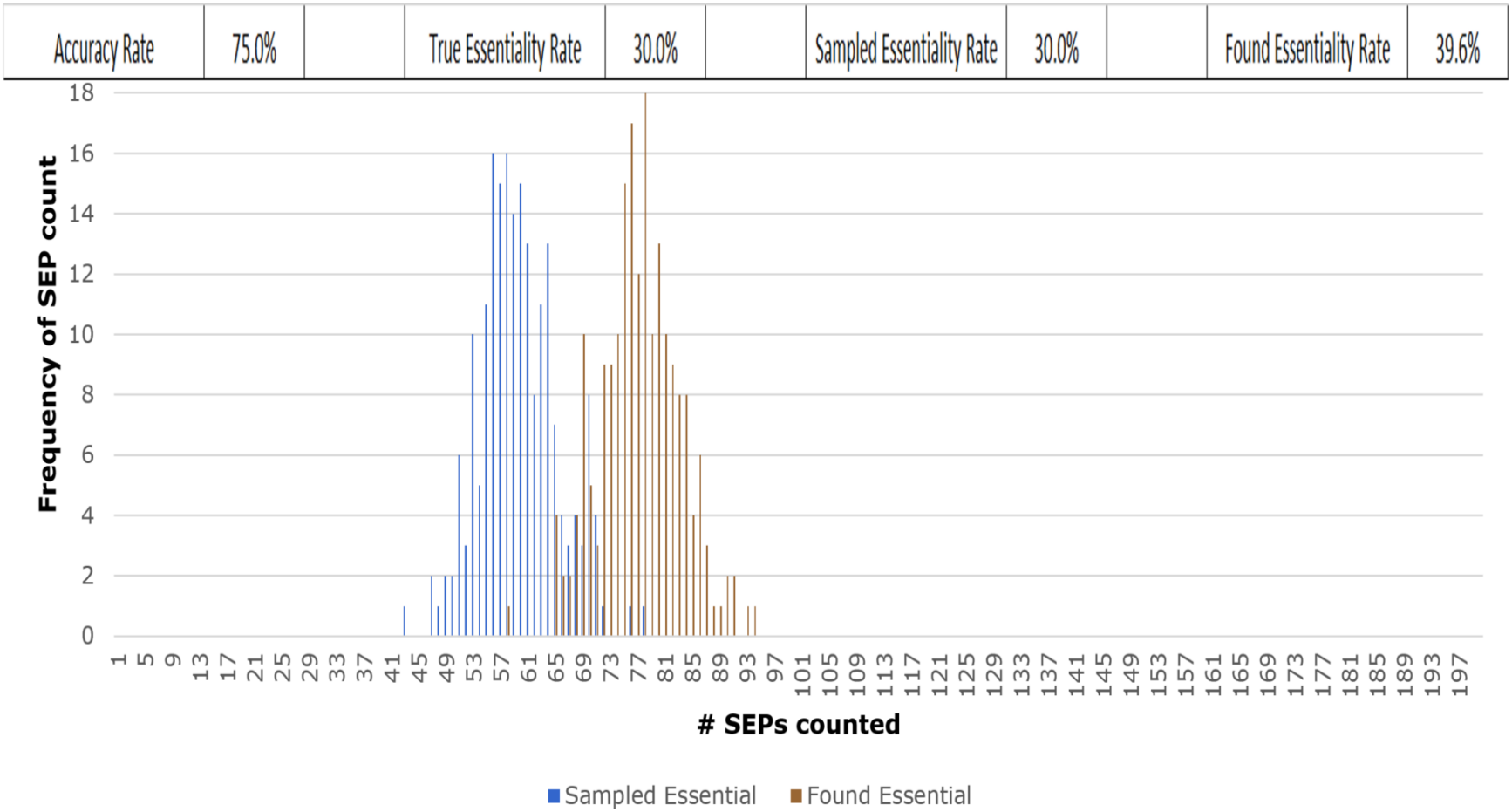
- **Deficiently inferring perfect essentiality determinations**

A Basic Assumption when Sampling

- **Ball colour can be determined with 100% accuracy**

- **But essentiality cannot be determined so accurately for declared-essential patents**
  - Inaccuracies increase variability in assessment results

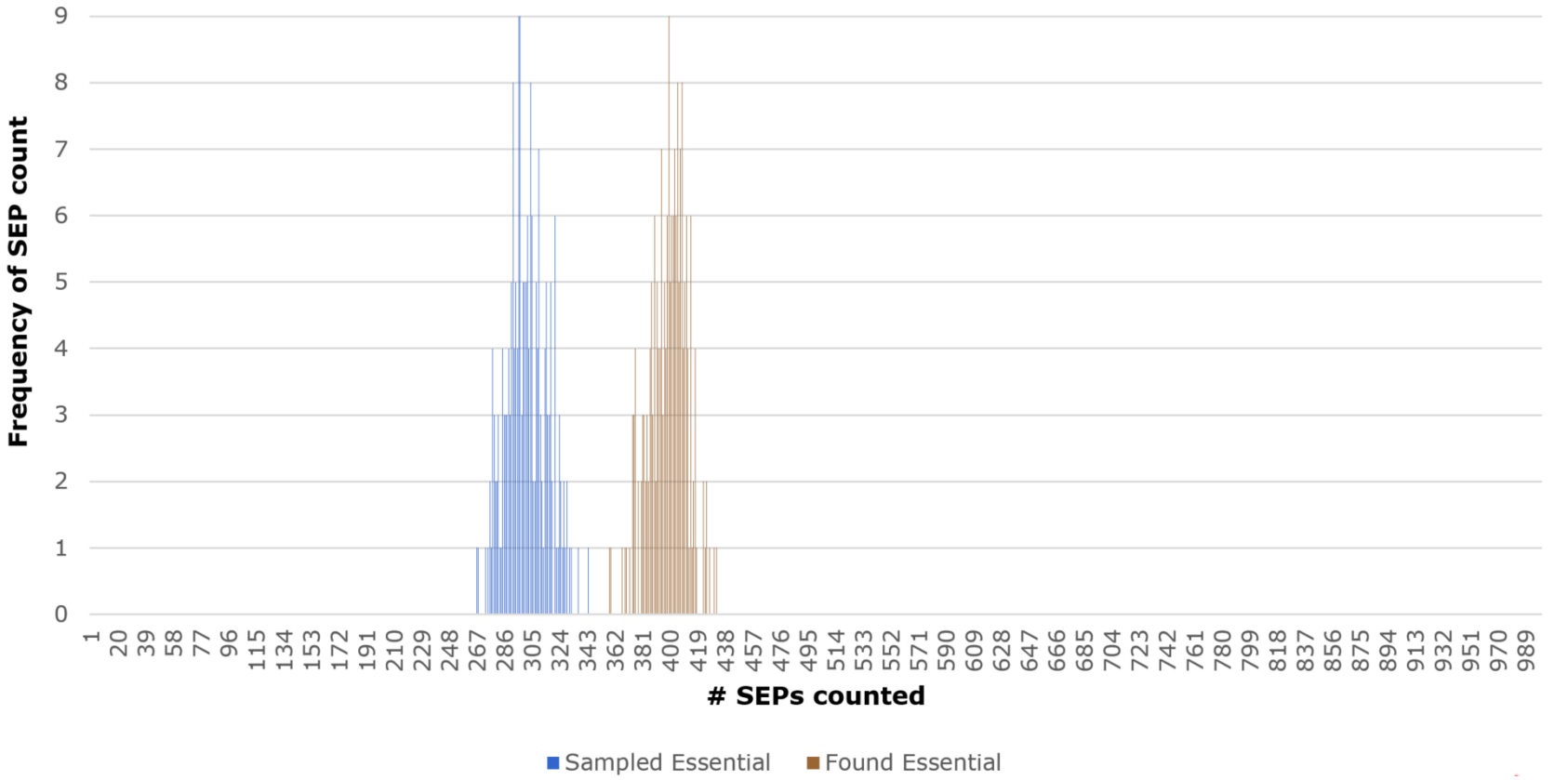
Number of SEPs Sampled and Found Essential



- **Samples of 200 patents with results averaged across 200 simulations**
- **Shows statistical bias and variability**

Number of SEPs Sampled and Found Essential

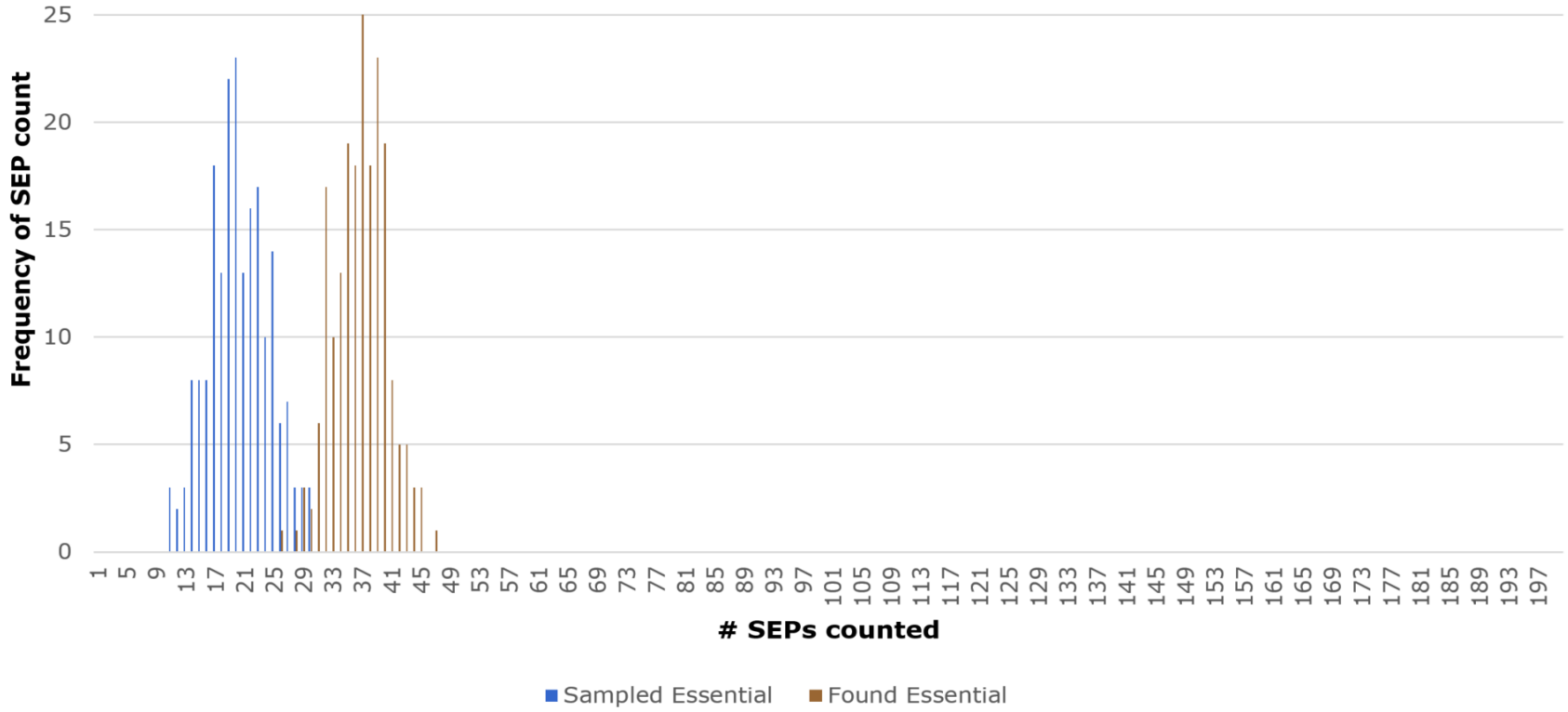
Accuracy Rate	75.0%		True Essentiality Rate	30.0%		Sampled Essentiality Rate	30.0%		Found Essentiality Rate	40.4%



- **from samples of 1,000 patents with results averaged across 1,000 simulations**
- **Shows bias and reduced variability with larger sample size**

Number of SEPs Sampled and Found Essential

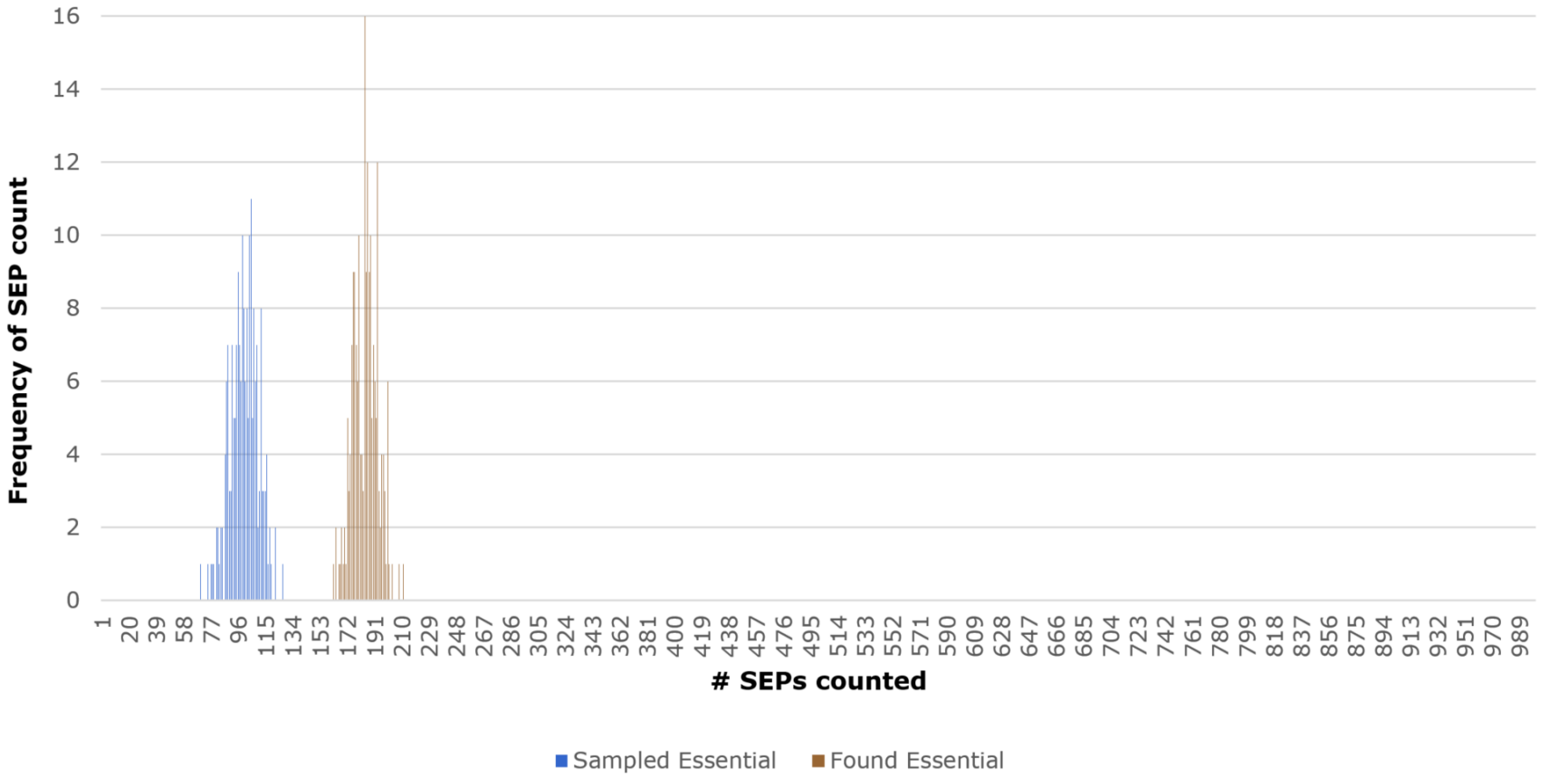
Accuracy Rate	91.0%		True Essentiality Rate	10.0%		Sampled Essentiality Rate	10.1%		Found Essentiality Rate	18.4%



- **Samples of 200 patents with results averaged across 1,000 simulations**
- **Shows statistical bias and variability**

Number of SEPs Sampled and Found Essential

Accuracy Rate	91.0%		True Essentiality Rate	10.0%		Sampled Essentiality Rate	10.0%		Found Essentiality Rate	18.4%



- **from samples of 1,000 patents with results averaged across 1,000 simulations**
- **Shows bias and reduced variability with larger sample size**

Variability in Determinations with 30% Essentiality, 85% Accuracy and Sample of 1,000

True Essentiality Rate TE	30%	**Accuracy Rate**	85%
Found Essentiality Rate	36%		

Samples of 1,000 patents with results averaged over 1,000 simulations

	Sampled Essentiality Rate SE			**Sampled and Found Essentiality Rate E1 or E2**		
	Mean	σ	1.96 x σ	Mean	σ	1.96 x σ
	30.0%	1.47%	2.88%	36.00%	1.56%	3.07%
Binomial theory prediction		*1.45%*				
Min@1.96x standard deviation(σ)			27.1%			32.9%
Max @ 1.96 x standard deviation			32.9%			39.1%
Difference (i.e., range @ 95% C.I. level)			5.8%			6.1%
Difference as percentage of TE			19.2%			20.4%
± percentage of TE (i.e., half of the above)			9.6%			10.2%

- **Standard deviation of SEP count due to sampling increases with imperfect essentiality determinations**

High Accuracy Rates and Larger Sample Sizes Required When True Essentiality Rates are Low

True Essentiality Rate TE	10%
Found Essentiality Rate	17%

Accuracy Rate	91%

Samples of 3,000 patents with results averaged over 1,000 simulations

	Sampled Essentiality Rate SE			**Sampled and Found Essentiality Rate E1 or E2**		
	Mean	σ	1.96 x σ	Mean	σ	1.96 x σ
	9.99%	0.54%	1.06%	17.19%	0.68%	1.33%
Binomial theory prediction		*0.55%*				
Min @ 1.96x standard deviation (σ)			8.9%			15.9%
Max @ 1.96 x standard deviation			11.1%			18.5%
Difference (i.e., range @ 95% C.I. level)			2.1%			2.7%
Difference as percentage of TE			21.3%			26.7%
± percentage of TE (i.e., half of the above)			10.6%			13.3%

- **Thousands of patents needed for ±15% accuracy "tolerance"**

Questions and Requirements for Further Work

- **In designing essentiality studies, particularly the official reference studies proposed by DG GROW's Expert group:**
  - Is adequate accuracy achievable?
  - How extensive: how many hours per patent assessment, use of claim charts, file histories, access to patent owners?
  - Sample sizes for denominator; and numerators?

- **False positives apparently swamp correct essentiality determinations where essentiality rates are low**
  - The proportion of false versus true positives is 9 times higher than false versus true negatives when the True Essentiality Rate is 10%
  - Additional empirical research is required to see if there is much difference in accuracy rates in determining:
    1. patents that are essential
    2. patents that are not essential

- **EC Pilot Study's proposed "statistical corrections" for false positives must be tested empirically to measure impact of additional false negatives on overall determination accuracy**

Accuracy versus Consistency of Assessors

- **Since it is not practically possible to determine which patents are truly essential**
  - Accuracy Rate (A) for assessors cannot be measured directly
- **However, Accuracy Rate can be inferred**
  - Consistency Rates (C) between assessors can be measured, as I did in *TCL v. Ericsson* and as in EC Pilot Study
  - By having two different assessors assess the same patents
- **The Consistency Rate at Different Accuracy Rates can be mathematically modelled**
  - Divide the total number of simulations in two (e.g. 500 each)
  - Compare individual patent essentiality determinations for each sample between two assessors at various Accuracy Rates
  - Measure how frequently they agree at each Accuracy Rate
- **Relationship between A and C is curved, and independent of True Essentiality Rate (TE)**

Found Essentiality Rates (FE) Again (Full Table)

		True Essentiality Rate (TE)																			
C	A	0%	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
100%	0%	100%	95%	90%	85%	80%	75%	70%	65%	60%	55%	50%	45%	40%	35%	30%	25%	20%	15%	10%	5%	0%
90.5%	5%	95%	91%	86%	82%	77%	73%	68%	64%	59%	55%	50%	46%	41%	37%	32%	28%	23%	19%	14%	10%	5%
82.0%	10%	90%	86%	82%	78%	74%	70%	66%	62%	58%	54%	50%	46%	42%	38%	34%	30%	26%	22%	18%	14%	10%
74.5%	15%	85%	82%	78%	75%	71%	68%	64%	61%	57%	54%	50%	47%	43%	40%	36%	33%	29%	26%	22%	19%	15%
68.0%	20%	80%	77%	74%	71%	68%	65%	62%	59%	56%	53%	50%	47%	44%	41%	38%	35%	32%	29%	26%	23%	20%
62.5%	25%	75%	73%	70%	68%	65%	63%	60%	58%	55%	53%	50%	48%	45%	43%	40%	38%	35%	33%	30%	28%	25%
58.0%	30%	70%	68%	66%	64%	62%	60%	58%	56%	54%	52%	50%	48%	46%	44%	42%	40%	38%	36%	34%	32%	30%
54.5%	35%	65%	64%	62%	61%	59%	58%	56%	55%	53%	52%	50%	49%	47%	46%	44%	43%	41%	40%	38%	37%	35%
52.0%	40%	60%	59%	58%	57%	56%	55%	54%	53%	52%	51%	50%	49%	48%	47%	46%	45%	44%	43%	42%	41%	40%
50.5%	45%	55%	55%	54%	54%	53%	53%	52%	52%	51%	51%	50%	50%	49%	49%	48%	48%	47%	47%	46%	46%	45%
50.0%	50%	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**	**50%**	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
50.5%	55%	**45%**	**46%**	**46%**	**47%**	**47%**	**48%**	**48%**	**49%**	**49%**	**50%**	**50%**	51%	51%	52%	52%	53%	53%	54%	54%	55%	55%
52.0%	60%	**40%**	**41%**	**42%**	**43%**	**44%**	**45%**	**46%**	**47%**	**48%**	**49%**	**50%**	51%	52%	53%	54%	55%	56%	57%	58%	59%	60%
54.5%	65%	**35%**	**36%**	**38%**	**39%**	**41%**	**42%**	**44%**	**45%**	**47%**	**48%**	**50%**	52%	53%	55%	56%	58%	59%	61%	62%	64%	65%
58.0%	70%	**30%**	**32%**	**34%**	**36%**	**38%**	**40%**	**42%**	**44%**	**46%**	**48%**	**50%**	52%	54%	56%	58%	60%	62%	64%	66%	68%	70%
62.5%	75%	**25%**	**27%**	**30%**	**32%**	**35%**	**37%**	**40%**	**42%**	**45%**	**47%**	**50%**	52%	55%	58%	60%	63%	65%	68%	70%	73%	75%
68.0%	80%	**20%**	**23%**	**26%**	**29%**	**32%**	**35%**	**38%**	**41%**	**44%**	**47%**	**50%**	53%	56%	59%	62%	65%	68%	71%	74%	77%	80%
74.5%	85%	**15%**	**18%**	**22%**	**25%**	**29%**	**32%**	**36%**	**39%**	**43%**	**46%**	**50%**	54%	57%	61%	64%	68%	71%	75%	78%	82%	85%
82.0%	90%	**10%**	**14%**	**18%**	**22%**	**26%**	**30%**	**34%**	**38%**	**42%**	**46%**	**50%**	54%	58%	62%	66%	70%	74%	78%	82%	86%	90%
90.5%	95%	**5%**	**9%**	**14%**	**18%**	**23%**	**27%**	**32%**	**36%**	**41%**	**45%**	**50%**	54%	59%	64%	68%	73%	77%	82%	86%	91%	95%
100%	100%	**0%**	**5%**	**10%**	**15%**	**20%**	**25%**	**30%**	**35%**	**40%**	**45%**	**50%**	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%

Consistency Rate (C), Accuracy Rate (A)

Thank You

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This presentation is mostly based on a recent WiseHarbor research paper and underlying simulation analysis that was summarised in IP Finance: http://www.ip.finance/2021/09/essentiality-rate-inflation-and-random.html, and published in full, here: https://www.wiseharbor.com/wp-content/uploads/2021/09/Perils-of-sampling-SEPs-Mallinson-30-Sept-2021.pdf

This presentation also cites two previous WiseHarbor publications on patent counting and top-down FRAND royalty rate setting that can be accessed here: http://www.ip.finance/2018/04/unreasonably-low-royalties-in-top-down.html and http://www.ip.finance/2017/05/do-not-count-on-accuracy-in-third-party.html

Many more WiseHarbor publications can be accessed here: https://www.wiseharbor.com/publications/