Initial Block Synchronization

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What is Initial Block Synchronization?

Initial Block Synchronization

(aka Initial Block Download)

1. Download blockchain
2. Validate blocks and transactions

Who does Initial Block Synchronization?

“[Bitcoin is] a solution to the double-spending problem using a peer-to-peer distributed timestamp server to generate computational proof of the chronological order of transactions.”

Initial Block Synchronization is how peers enter the bitcoin peer-to-peer network.

All bitcoin peers need to complete Initial Block Synchronization.

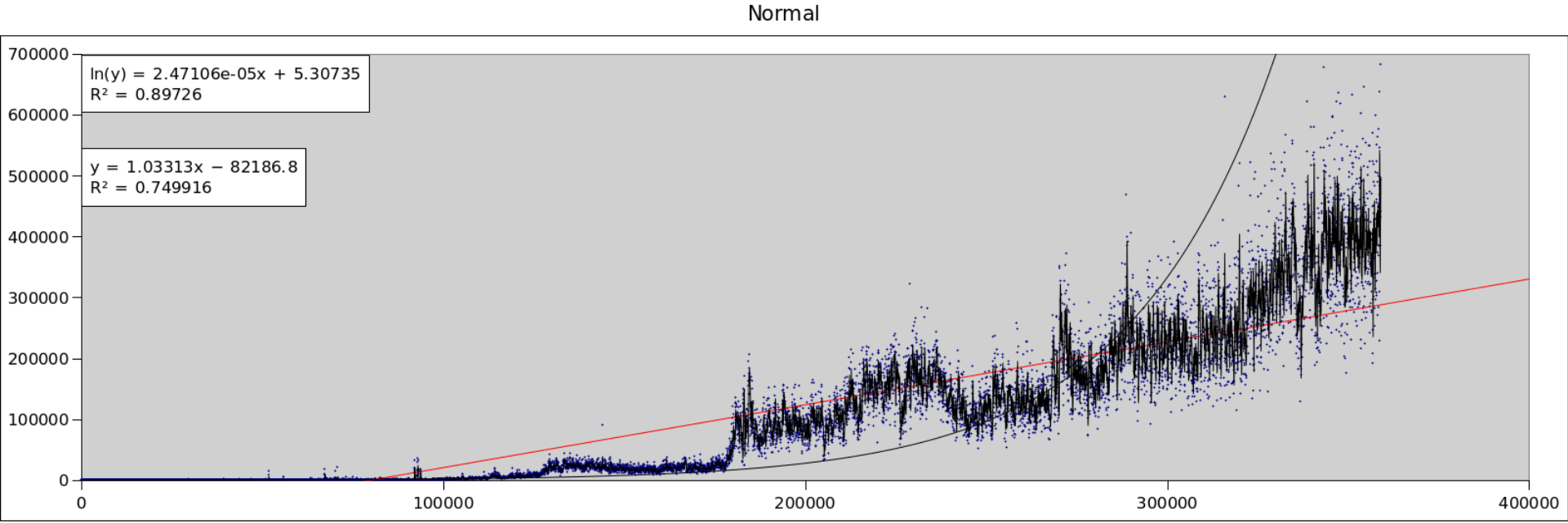
Runtime Complexity of Initial Block Synchronization

BSG(n) = Block Size Growth

IBS(n) = Integral[BSG[n], n]

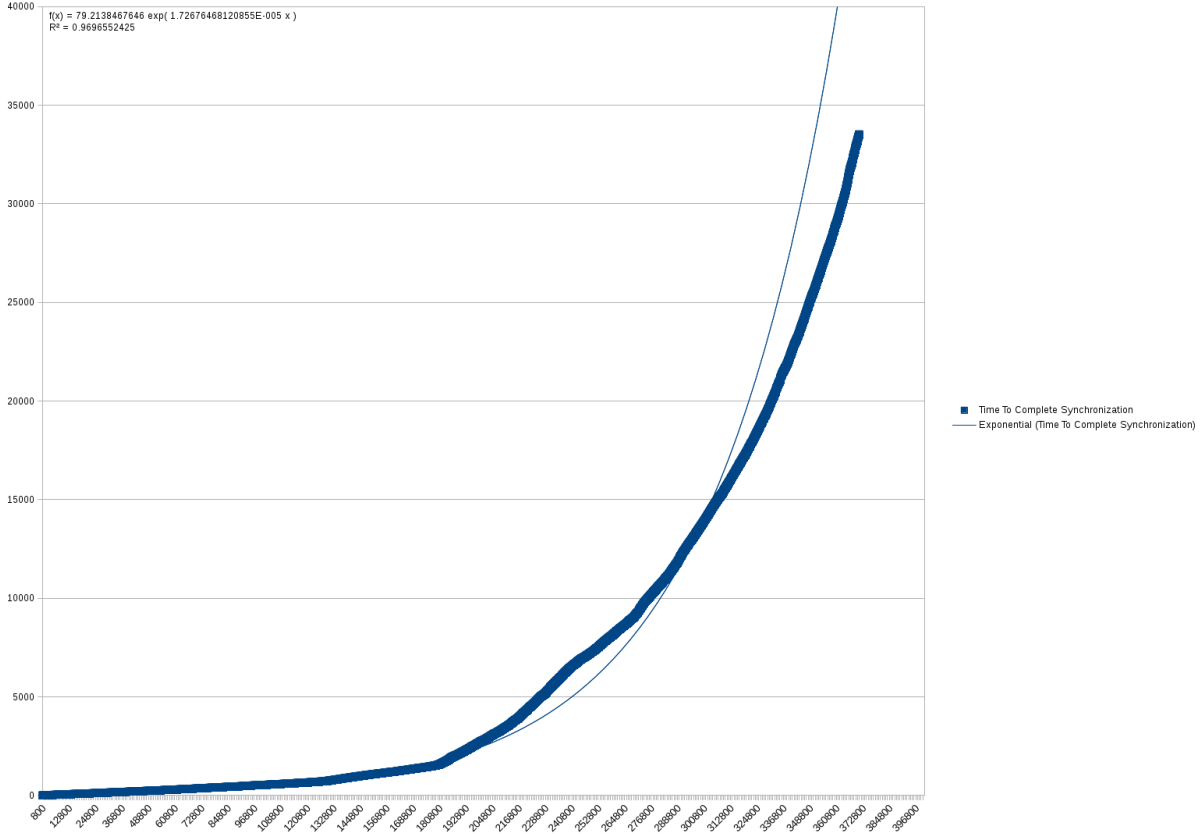
Block Size Growth	Initial Block Synchronization Time
O(1)	O(n)
O(n)	O(n^2)
O(n^2)	O(n^3)
O(2^n)	O(2^n)

Real Data - Block Size



http://rusty.ozlabs.org/?p=498

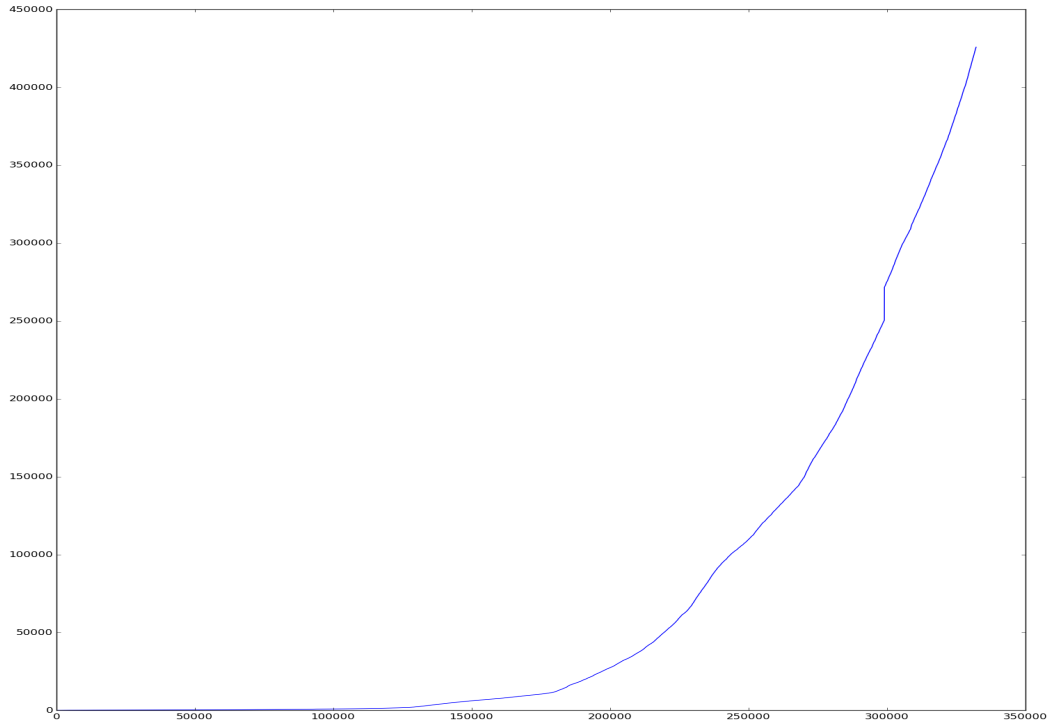
Real Data -Initial Block Synchronization



i7-4700MQ 4c/8ht
32 GB memory
Samsung 840 EVO mSata

Connected to peer on 1 Gbit/s LAN.

Real Data -Initial Block Synchronization



RaspberryPi 2
ARMv7 4 cores
1GB memory
USB 3.0 external HDD

Connected to peer on 1 Gbit/s LAN.

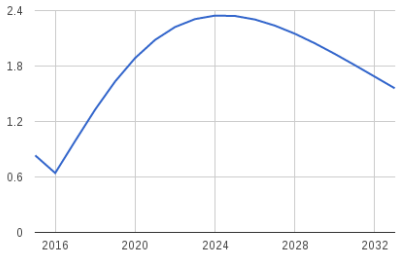
Note: node isn’t fully synchronized yet!

Simulating Linear Blocksize Growth
20% annual capacity improvement

Year	Transactions Per Year	Transactions Total	Capacity Improvement	Adjusted Cost	Linear Relative Adjusted Cost
2015	19,643,846.00	75,123,940.00	1.20	62,603,283.33	0.8333333333
2016	39,287,692.00	69,504,375.00	1.44	48,266,927.08	0.6424972796
2017	58,931,538.00	128,435,913.00	1.73	74,326,338.54	0.9893828591
2018	78,575,384.00	207,011,297.00	2.07	99,831,836.90	1.328895115
2019	98,219,230.00	305,230,527.00	2.49	122,665,303.10	1.632839054
2020	117,863,076.00	423,093,603.00	2.99	141,693,191.59	1.886125669
2021	137,506,922.00	560,600,525.00	3.58	156,453,317.96	2.082602669
2022	157,150,768.00	717,751,293.00	4.30	166,926,010.96	2.222008204
2023	176,794,614.00	894,545,907.00	5.16	173,368,989.76	2.307772859
2024	196,438,460.00	1,090,984,367.00	6.19	176,200,066.12	2.345458267
2025	216,082,306.00	1,307,066,673.00	7.43	175,915,470.75	2.341669922
2026	235,726,152.00	1,542,792,825.00	8.92	173,034,482.28	2.303320117
2027	255,369,998.00	1,798,162,823.00	10.70	168,063,272.49	2.237146674
2028	275,013,844.00	2,073,176,667.00	12.84	161,472,610.94	2.149416164
2029	294,657,690.00	2,367,834,357.00	15.41	153,685,405.42	2.045758056
2030	314,301,536.00	2,682,135,893.00	18.49	145,071,079.01	1.931089863
2031	333,945,382.00	3,016,081,275.00	22.19	135,944,567.56	1.809603804
2032	353,589,228.00	3,369,670,503.00	26.62	126,568,317.63	1.684793391
2033	373,233,074.00	3,742,903,577.00	31.95	117,156,115.70	1.55950441

Assumptions:

- 19,643,846 additional transactions per year
- 20% annual drop in the price of bandwidth

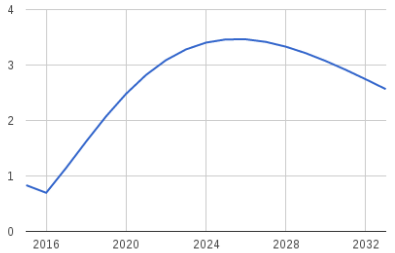


Simulating 20% annual Blocksize Growth
20% annual bandwidth improvement

Year	Transactions Per Year	Transactions Total	Capacity Improvement	Adjusted Cost	Exponential Relative Adjusted Cost
2015	19,643,846.00	75,123,940.00	1.20	62,603,283.33	0.8333333333
2016	45,129,707.17	75,346,390.17	1.44	52,323,882.06	0.6965007701
2017	73,412,840.21	148,759,230.38	1.73	86,087,517.58	1.145939864
2018	103,680,840.78	252,440,071.16	2.07	121,740,003.45	1.620522079
2019	135,515,984.96	387,956,056.11	2.49	155,910,837.88	2.075381535
2020	168,658,417.56	556,614,473.67	2.99	186,409,061.02	2.481353627
2021	202,929,025.02	759,543,498.70	3.58	211,974,650.76	2.82166578
2022	238,196,022.50	997,739,521.19	4.30	232,042,324.24	3.088793323
2023	274,357,939.23	1,272,097,460.42	5.16	246,541,010.21	3.281790202
2024	311,333,977.99	1,583,431,438.41	6.19	255,733,017.43	3.404148097
2025	349,058,118.14	1,932,489,556.55	7.43	260,089,876.88	3.462143717
2026	387,475,293.62	2,319,964,850.17	8.92	260,199,496.81	3.463602905
2027	426,538,800.74	2,746,503,650.90	10.70	256,698,884.87	3.417005083
2028	466,208,474.45	3,212,712,125.35	12.84	250,227,114.42	3.330857173
2029	506,449,365.82	3,719,161,491.17	15.41	241,393,930.24	3.213275691
2030	547,230,758.42	4,266,392,249.59	18.49	230,760,167.20	3.0717261
2031	588,525,420.67	4,854,917,670.26	22.19	218,826,889.29	2.912878229
2032	630,309,026.94	5,485,226,697.20	26.62	206,030,801.60	2.742545207
2033	672,559,701.90	6,157,786,399.11	31.95	192,744,034.41	2.565680586

Assumptions:

- 19,643,846 additional transactions per year
- 20% annual drop in the price of bandwidth



Simulating 20% annual Blocksize Growth
10% annual bandwidth improvement

Year	Transactions Per Year	Transactions Total	Capacity Improvement	Adjusted Cost	20% Exponential 10% Improvement
2015	19,643,846.00	75,123,940.00	1.10	68,294,490.91	0.9090909091
2016	45,129,707.17	75,346,390.17	1.21	62,269,743.94	0.8288934785
2017	73,412,840.21	148,759,230.38	1.33	111,765,011.55	1.487741611
2018	103,680,840.78	252,440,071.16	1.46	172,419,965.27	2.295140075
2019	135,515,984.96	387,956,056.11	1.61	240,890,187.65	3.206570205
2020	168,658,417.56	556,614,473.67	1.77	314,194,359.48	4.182346659
2021	202,929,025.02	759,543,498.70	1.95	389,765,912.51	5.188304986
2022	238,196,022.50	997,739,521.19	2.14	465,452,850.16	6.195799237
2023	274,357,939.23	1,272,097,460.42	2.36	539,493,503.30	7.181379242
2024	311,333,977.99	1,583,431,438.41	2.59	610,481,365.35	8.126322519
2025	349,058,118.14	1,932,489,556.55	2.85	677,325,800.38	9.016111247
2026	387,475,293.62	2,319,964,850.17	3.14	739,212,297.27	9.839903196
2027	426,538,800.74	2,746,503,650.90	3.45	795,564,276.48	10.59002332
2028	466,208,474.45	3,212,712,125.35	3.80	846,007,513.69	11.26149019
2029	506,449,365.82	3,719,161,491.17	4.18	890,337,691.31	11.85158408
2030	547,230,758.42	4,266,392,249.59	4.59	928,491,258.22	12.35945902
2031	588,525,420.67	4,854,917,670.26	5.05	960,519,579.01	12.78579876
2032	630,309,026.94	5,485,226,697.20	5.56	986,566,236.14	13.13251456
2033	672,559,701.90	6,157,786,399.11	6.12	1,006,847,282.06	13.40248238

Assumptions:

- 20% annual increase in blocksize
- 10% annual drop in the price of bandwidth