

# Memo

**To:** Gail McGovern, IFRC  
**From:** Jennifer Grosz, Josh Wolfe  
**cc:** Justin Gapper  
**Date:** 8/6/2020  
**Re:** Africa Disaster/Disease Relief Plan

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We have attached a graphic that breaks down each destination's time to delivery, the costs associated, and the supplies required in Appendix A.

In accordance with the IFRC's request to develop a transportation plan with the shortest delivery time with a "cost is no object" mindset, we have found the following:

New York, NY will send workers and supplies to Libreville, Gabon, and Lunda, Angola via ship while Khartoum, Sudan is supplied via air. Jacksonville, FL will send workers and supplies to Dakar, Senegal via ship while Lusaka, Zambia and Nairobi, Kenya are supplied via air. Khartoum, Sudan will send workers and supplies to Niamey, Chad, Kosongo, D.R Congo, and Ndjamen, Niger via air. The Fastest route to supply the strategic cities of Ndjamen, Kosongo, and Niamey are via air out of NY to Khartoum and takes about 21 hours for each city. The slowest of the fast routes is the ones to supply the port cities of Dakar, Libreville, and Lunda. These routes take as much as 7 days and 18 hours via ship. A graphic showing the routes is available in Appendix B.

For bottlenecks, it appears that all supplies leaving NY and FL by ship are the slowest to reach the IFRC destinations, which is unfortunate since the cargo ships are capable of transporting the most units of supplies when compared to the other modes of transportation (airplanes and trucks). Increasing the speed of the ships by 10 miles per hour can reduce the total travel time for supplies by a minimum of 24 hours (1 day) and 54 minutes and a maximum of 1 day 19 hours and 21 minutes. While this difference does not make a very significant difference in overall travel speed, it does have an incremental impact on decreasing the travel time of the cargo ships. See Appendix C for further details.

In accordance with the IFRC's request for a minimalized cost plan we have found the following:

The minimum cost to send the required supplies to each IFRC destination is \$310861299 (when rounding up the number of airplanes/ships/trucks to account for decimal numbers the total cost is \$311025000). See Appendix D for further details.

New York, NY will send 50,000 units on 209 ships to Dakar, Senegal, 280,000 units on 1,167 ships to Libreville, Gabon, 130,000 units on 542 ships to Lunda, Angola and 40,000 units on 267 airplanes to Lusaka, Zambia.

Jacksonville, FL will send 220,000 units on 1,467 airplanes to Khartoum, Sudan, 110,000 units on 734 airplanes to Lusaka, Zambia, and 170,000 units on 1,134 airplanes to Nairobi, Kenya.

Libreville, Gabon will send 180,000 units on 10,170 trucks to Kosongo, D.R. Congo.

Khartoum, Sudan will send 100,000 units on 667 airplanes to Niamey, Niger and 30,000 units on 200 airplanes to Ndjamena, Chad.

Nairobi, Kenya will send 50,000 units on 334 airplanes to Ndjamena, Chad.

We have identified the following potential bottlenecks in this system. First, there is a 3 hour and 36 minute travel time difference between when the airplanes from Khartoum, Sudan will arrive in Ndjamena, Chad and when the airplanes from Nairobi, Kenya will arrive if they depart for Ndjamena at the same time. The next bottleneck we found was on the route to get supplies to Kosongo, D.R. Congo. Since the least expensive route is for supplies to come from NY to Libreville, Gabon and then from Libreville to Kosongo, D.R. Congo the total travel time for supplies coming from the US to arrive in Kosongo is 208 hours 57 minutes (8 days, 16 hours and 57 minutes). See Appendix E.

Another bottleneck would be due to the cargo load size capabilities. With the current cargo restrictions, we are often sending one extra ship, airplane, or truck due to a small amount of remaining required supplies. If there was some way to increase the cargo load size to exactly match the required supplies, we could eliminate the extra transportation cost of one more trip that is carrying a load below capacity.

In accordance with the IFC's request to maximize the amount of cargo that reaches Africa we have found the following:

The maximum amount of cargo that can be sent to Africa 816,170 units. See Appendix F for a graphical break down.

New York will send 500,000 total units to Africa. 67,185 units to Dakar, Senegal, 75,000 units to Khartoum, Sudan, 108,142 units to Libreville, Gabon, 45,000 units to Luska, Zambia, 138,673 units to Lunda, Angola, and 66,000 units to Nairobi, Kenya.

Florida will send 316,170 total units to Africa. 58,170 units to Dakar, Senegal, 78,000 units to Khartoum, Sudan, 75,000 units to Luska, Zambia, and 105,000 units to Nairobi, Kenya.

Dakar, Senegal will send 55,000 units to Niamey, Niger, 12,390 units to Kosongo, D.R. Congo, and 7,965 units to Ndjamena, Chad. Dakar will keep 50,000 units.

Khartoum, Sudan will send 45,000 units to Niamey, Niger, 12,000 units to Kosongo, D.R. Congo, and 6,000 units to Ndjamena, Chad. Khartoum will keep 90,000 units.

Libreville, Gabon will send 5,310 units to Kosongo, D.R. Congo, and 2,832 units to Ndjamena, Chad. Libreville will keep 100,000 units.

Lusaka, Zambia will send 21,000 units to Kosongo, D.R. Congo. Lusaka will keep 99,000 units.

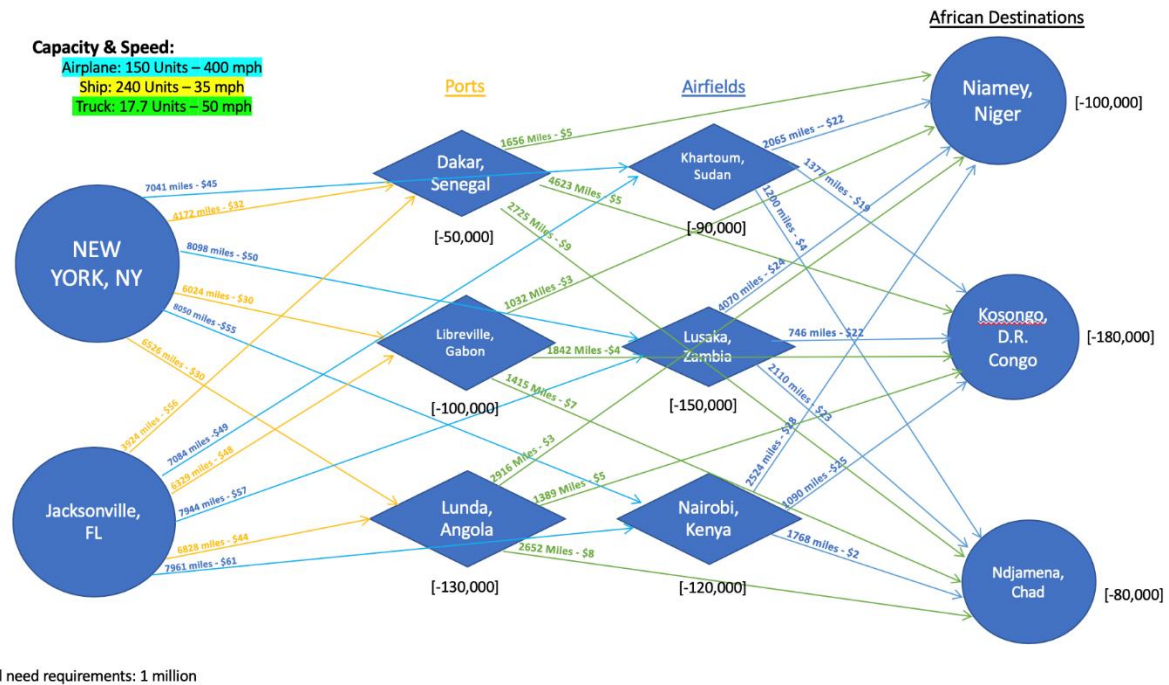
Lunda, Angola will send 4,425 units to Kosongo, D.R. Congo, and 4,248 units to Ndjamena, Chad. Lunda will keep 130,000 units.

Nairobi, Kenya will send 6,000 units to Kosongo, D.R. Congo, and 45,000 units to Ndjamena, Chad. Nairobi will keep 120,000 units.

Niamey, Niger will receive 100,000 units, Kosongo, D.R. Congo, will receive 61,125 units, and Ndjamena, Chad will receive 66,045 units.

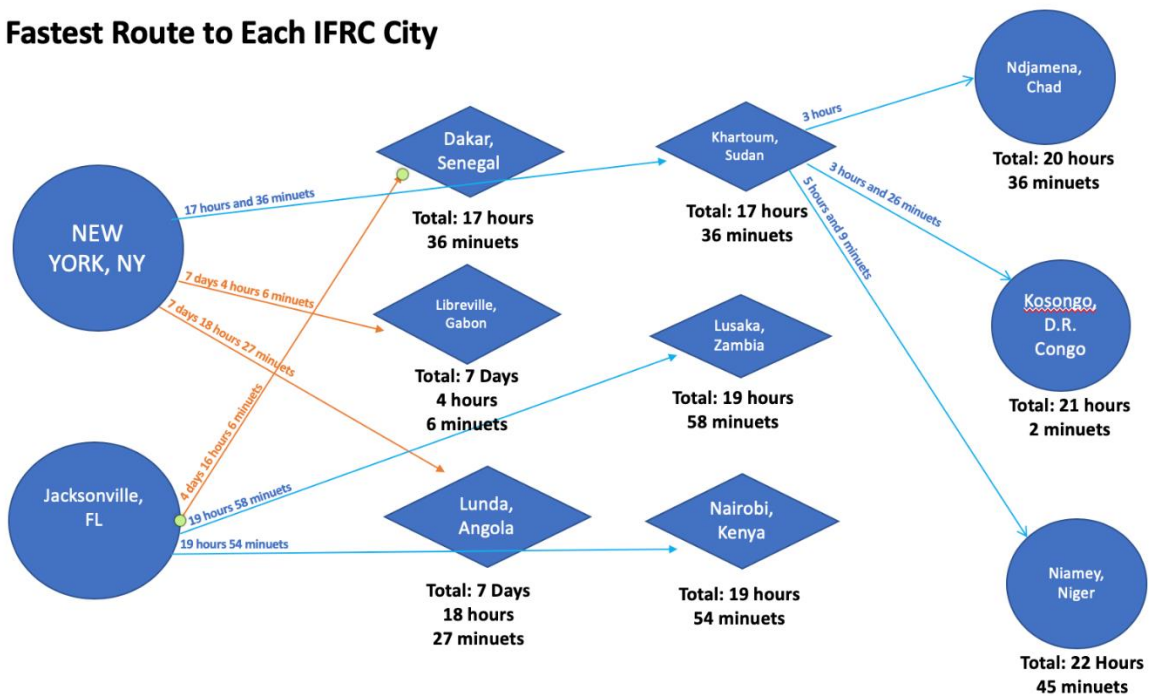
The most significant bottlenecks in this system are the airplane and truck restrictions for delivering supplies to Lusaka, Zambia, Kosongo, D.R. Congo and Ndjamena, Chad. The result of these restrictions is the US under-delivering on units of required supplies. Kosongo, D.R. Congo has the largest difference in delivered supplies to required supplies by -118,875 units, followed by Lusaka with -51,000 units, and Chad is not receiving -13,955 units compared to their requirements. See Appendix G.

## Appendix A:



## Appendix B:

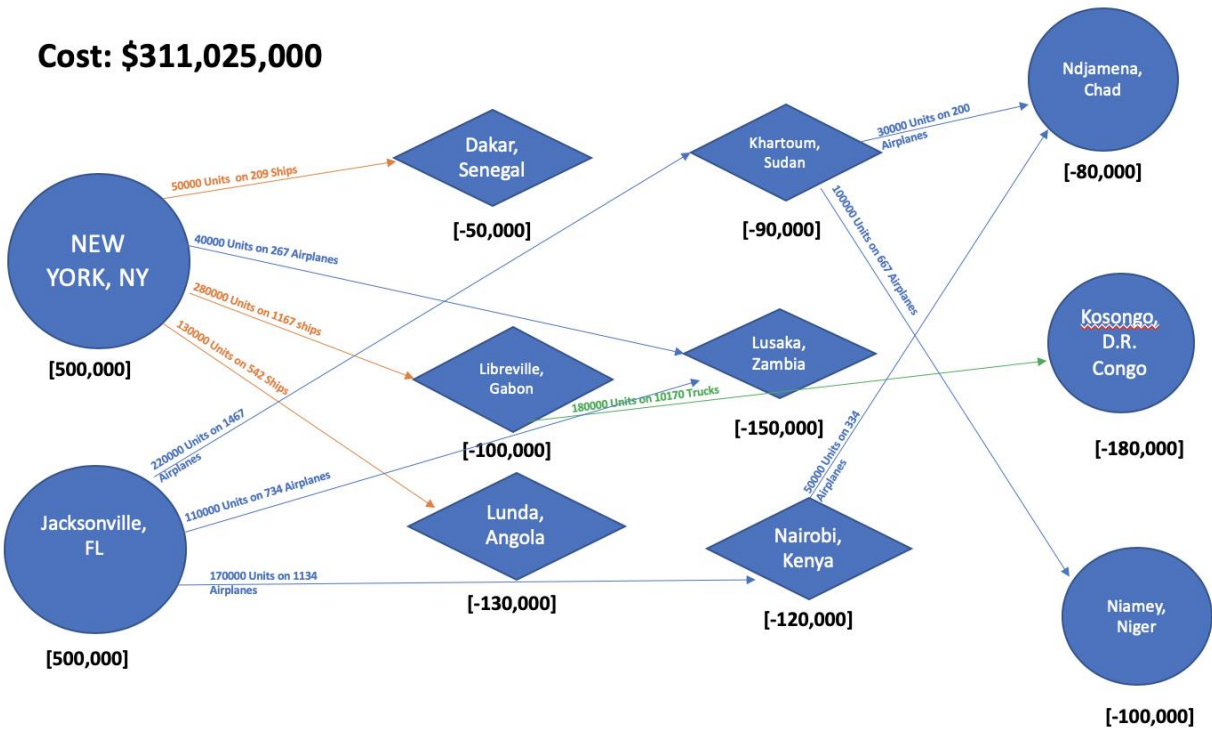
### Fastest Route to Each IFRC City



Appendix C:

Comparing Increased Ship mph Travel Time													
From	To	Type	Distance(miles)	Speed (mph)	New time to destination (hours)	Previous time to destination (at 35 mph)	Difference in Travel Time (Hours)						
New York, NY	Dakar, Senegal	Ship	4172	45	92.71111111	119.2	-26.48888889						
Jacksonville, FL	Dakar, Senegal	Ship	3924	45	87.2	112.1142857	-24.9142857						
New York, NY	Luanda, Angola	Ship	6526	45	145.0222222	186.4571429	-41.43492068						
Jacksonville, FL	Luanda, Angola	Ship	6828	45	151.7333333	195.0857143	-43.35238097						
New York, NY	Libreville, Gabon	Ship	6024	45	133.8666667	172.1142857	-38.24761903						
Jacksonville, FL	Libreville, Gabon	Ship	6329	45	140.6444444	180.8285714	-40.18412696						
From	To	Type	Distance (miles)	Increased Speed (10 mph incre)	New Travel time (hours)	From	To	Type	Distance (miles)	Speed (mph)	Travel time (hours)	New Time to Destination (hours)	Difference in Travel Time (Hours)
New York, NY	Dakar, Senegal	Ship	4172	45	92.71111111	Dakar, Senegal	Niamey, Niger	Truck	1656	50	33.12	125.8311111	-26.49
New York, NY	Dakar, Senegal	Ship	4172	45	92.71111111	Dakar, Senegal	Kosongo, D.R. Congo	Truck	4623	50	92.46	185.1711111	-26.49
New York, NY	Dakar, Senegal	Ship	4172	45	92.71111111	Dakar, Senegal	Ndjamena, Chad	Truck	2725	50	54.5	147.2111111	-26.49
Jacksonville, FL	Dakar, Senegal	Ship	3924	45	87.2	Dakar, Senegal	Niamey, Niger	Truck	1656	50	33.12	120.32	-24.91
Jacksonville, FL	Dakar, Senegal	Ship	3924	45	87.2	Dakar, Senegal	Kosongo, D.R. Congo	Truck	4623	50	92.46	179.66	-24.91
Jacksonville, FL	Dakar, Senegal	Ship	3924	45	87.2	Dakar, Senegal	Ndjamena, Chad	Truck	2725	50	54.5	141.7	-24.91
New York, NY	Luanda, Angola	Ship	6526	45	145.0222222	Luanda, Angola	Niamey, Niger	Truck	2916	50	58.32	203.3422222	-41.43
New York, NY	Luanda, Angola	Ship	6526	45	145.0222222	Luanda, Angola	Kosongo, D.R. Congo	Truck	1389	50	27.78	172.8022222	-41.43
New York, NY	Luanda, Angola	Ship	6526	45	145.0222222	Luanda, Angola	Ndjamena, Chad	Truck	2652	50	53.04	198.0622222	-41.43
Jacksonville, FL	Luanda, Angola	Ship	6828	45	151.7333333	Luanda, Angola	Niamey, Niger	Truck	2916	50	58.32	210.0533333	-43.35
Jacksonville, FL	Luanda, Angola	Ship	6828	45	151.7333333	Luanda, Angola	Kosongo, D.R. Congo	Truck	1389	50	27.78	179.5133333	-43.35
Jacksonville, FL	Luanda, Angola	Ship	6828	45	151.7333333	Luanda, Angola	Ndjamena, Chad	Truck	2652	50	53.04	204.7733333	-43.35
New York, NY	Libreville, Gabon	Ship	6024	45	133.8666667	Libreville, Gabon	Niamey, Niger	Truck	1032	50	20.64	154.5066667	-38.25
New York, NY	Libreville, Gabon	Ship	6024	45	133.8666667	Libreville, Gabon	Kosongo, D.R. Congo	Truck	1842	50	36.84	170.7066667	-38.25
New York, NY	Libreville, Gabon	Ship	6024	45	133.8666667	Libreville, Gabon	Ndjamena, Chad	Truck	1415	50	28.3	162.1666667	-38.25
Jacksonville, FL	Libreville, Gabon	Ship	6329	45	140.6444444	Libreville, Gabon	Niamey, Niger	Truck	1032	50	20.64	161.2844444	-40.18
Jacksonville, FL	Libreville, Gabon	Ship	6329	45	140.6444444	Libreville, Gabon	Kosongo, D.R. Congo	Truck	1842	50	36.84	177.4844444	-40.18
Jacksonville, FL	Libreville, Gabon	Ship	6329	45	140.6444444	Libreville, Gabon	Ndjamena, Chad	Truck	1415	50	28.3	168.9444444	-40.18

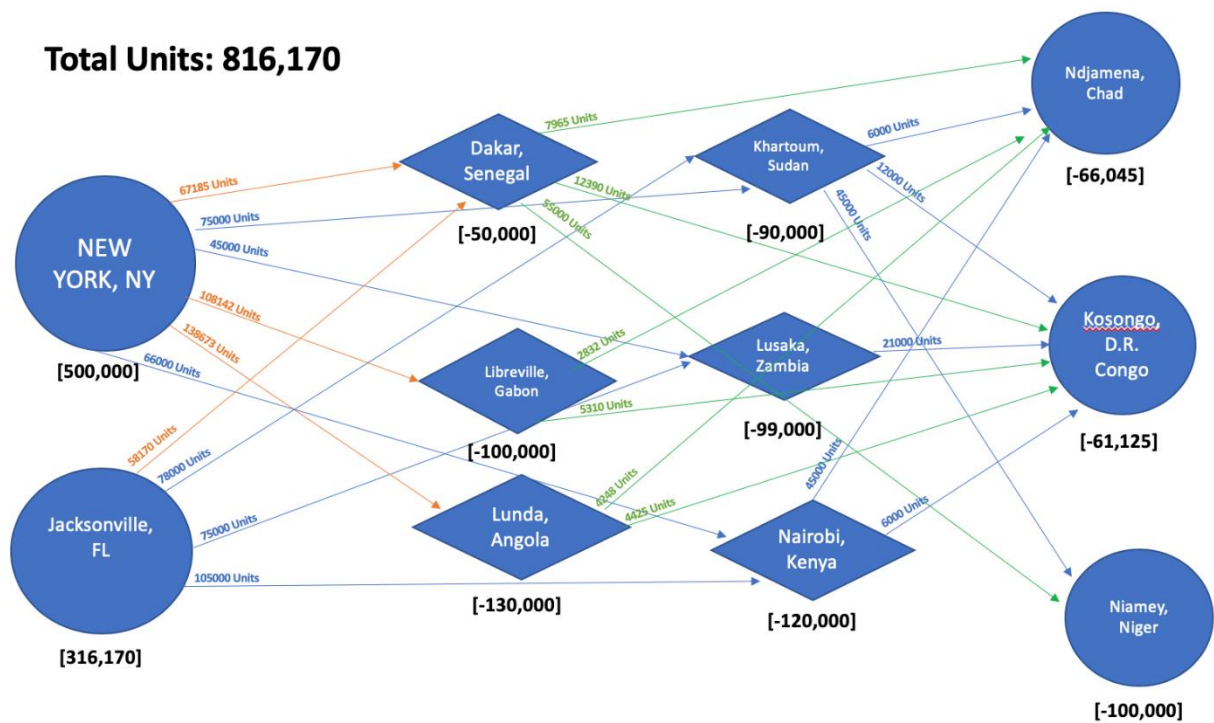
Appendix D:



Appendix E:

From	To	Travel time (hours)	Time to Destination (hours & minutes)	Difference between Arrival times	From	To	Type	Distance (miles)	Speed (mph)	Travel time (hours)	Time to Destination (hours)	Time to Destination (hours & minutes)
New York, NY	Dakar, Senegal	119.2	118 hours 12 minuets									
New York, NY	Libreville, Gabon	172.1142857	172 hours 6 minuets									
New York, NY	Lusaka, Zambia	20.245	20 hours 14 minuets									
New York, NY	Luanda, Angola	186.4571429	186 hours 27 minuets									
Jacksonville, FL	Luanda, Angola	195.0857143	195 hours 5 minuets									
Jacksonville, FL	Nairobi, Kenya	19.9025	19 hours 54 minuets									
Jacksonville, FL	Khartoum, Sudan	17.71	17 hours 42 minuets									
Jacksonville, FL	Khartoum, Sudan	17.71	17 hours 42 minuets		Khartoum, Sudan	Niamey, Niger	Airplane	2065	400	5.1625	22.8725	22 hours 52 minuets
Jacksonville, FL	Khartoum, Sudan	17.71	17 hours 42 minuets	Airplane from Khartoum, Sudan will arrive 3 hours and 36 minuets before the airplane from Nairobi, Kenya	Khartoum, Sudan	Ndjamena, Chad	Airplane	1200	400	3	20.71	20 hours 42 minuets
Jacksonville, FL	Nairobi, Kenya	19.9025	19 hours 54 minuets		Nairobi, Kenya	Ndjamena, Chad	Airplane	1768	400	4.42	24.3225	24 hours 19 minuets
New York, NY	Libreville, Gabon	172.1142857	172 hours 6 minuets		Libreville, Gabon	Kosongo, D.R. Congo	Truck	1842	50	36.84	208.9542857	208 hours 57 minuets

Appendix F:



**Appendix G:**

	Delivered Units	Required Units	Amount Missing
NY	500,000	500,000	-
FL	316,170	500,000	(-183,830)
Dakar	50,000	50,000	-
Khartoum	90,000	90,000	-
Liberville	100,000	100,000	-
Luska	99,000	150,000	(-51,000)
Lunda	130,000	130,000	-
Nairobi	120,000	120,000	-
Niamey	100,000	100,000	-
Kosongo	61,125	180,000	(-118,875)
Ndjamena	66,045	80,000	(-13,955)