

LOCATION PROBLEM

Decisions

- Locations of a given number of new Roadside Wellness Centers
- Which optional service packages these RWCs should offer

OPTIMIZATION CRITERIA

1. Maximize patient volume

- Choose locations that attract many truck driver patients

2. Enhance continuity of access

- Choose locations that ensure adequate access at any point of time during the truck drivers' trips
- Travel time gaps between RWCs should not be too large
- Particularly important for health services that require frequent clinic visits (HIV & TB treatment)

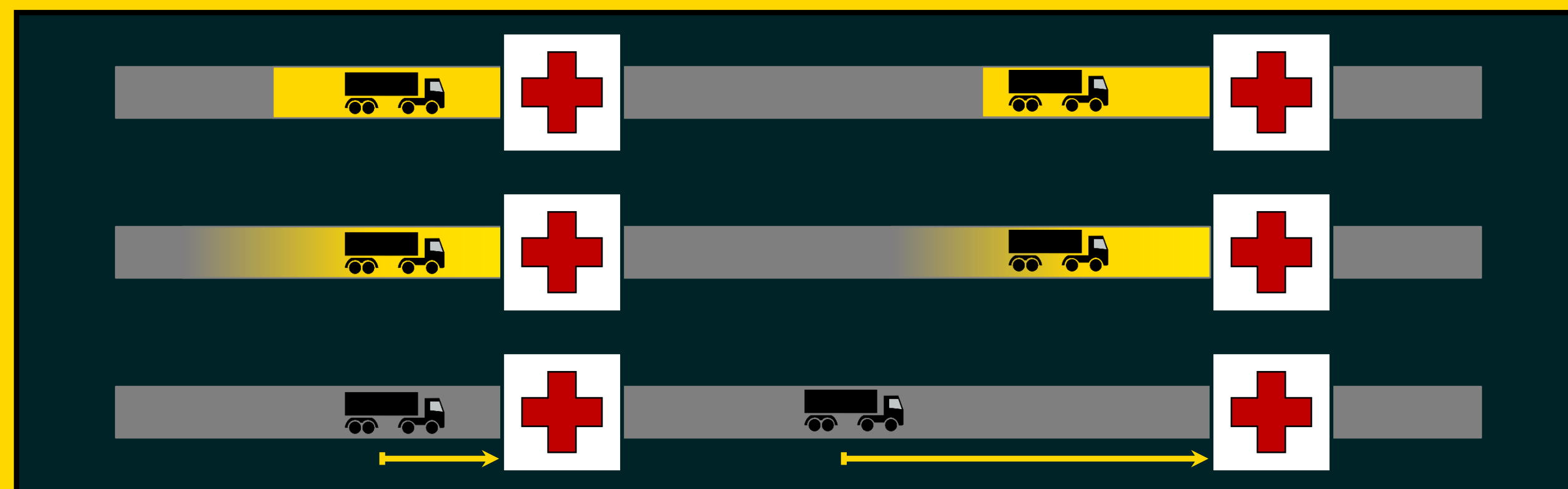
MEASURING ACCESS TO HEALTHCARE

Traditional access measures

- Based on distance/ travel time between patient and provider
- Not suitable for mobile patients like truck drivers

Three access measures for mobile patients

- CTL: fraction of time within a critical time limit from a health facility
- RCTL: fraction of time within a critical time limit & fraction of time within a recommended time limit
- ASAP: expected travel time to nearest facility when needed



SOLUTION METHOD

Mixed Integer Programming (MIP) formulation

- Objective function:

$$\max r \cdot \text{Patient Volume} + (1 - r) \cdot \text{Continuous Access Score}$$
- Continuous Access Score:

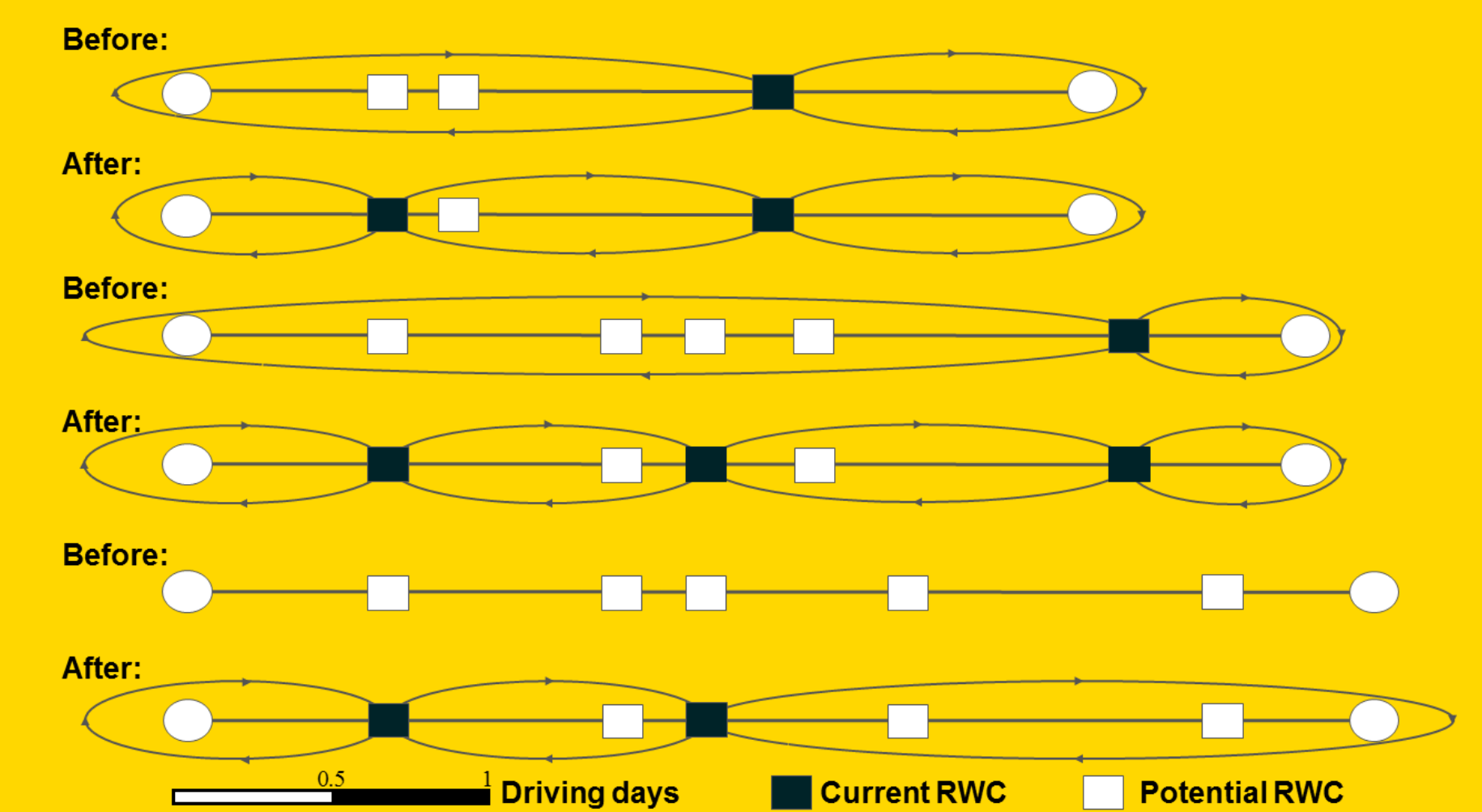
$$\sum_{\text{Service packages: } s} \sum_{\text{Truck routes: } q} (\text{Truck Volume}_{sq} \cdot \text{Access Score}_{sq})$$
- Solved by CPLEX 12.5

CASE STUDY RESULTS

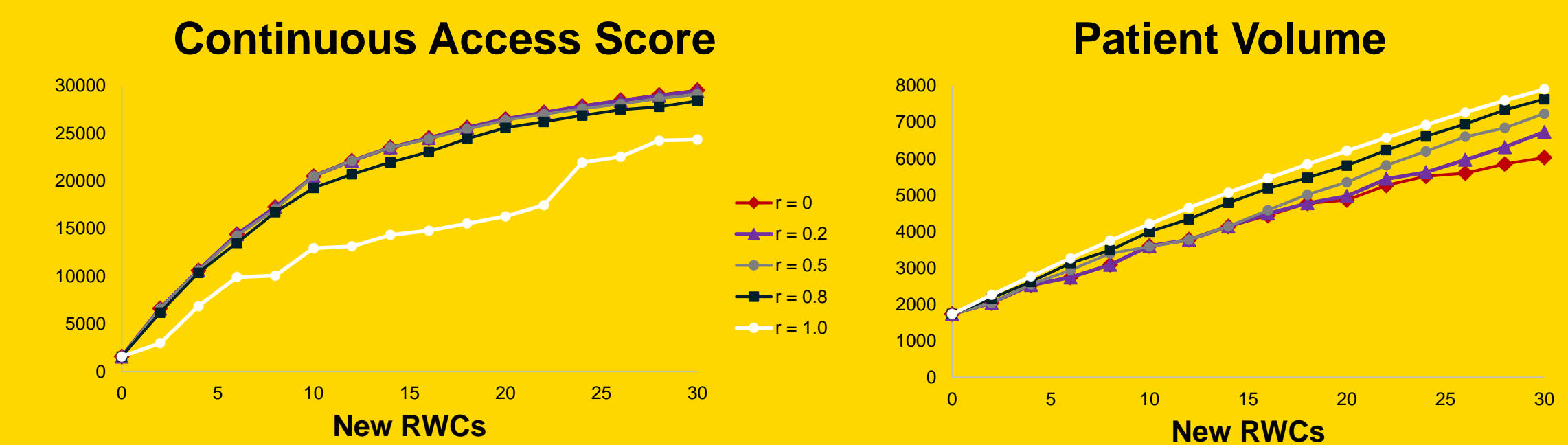
Case study: North South Corridor network

- Location decisions have a huge impact in terms of continuity of access.

- E.g. situation along three major corridors before and after adding 4 RWCs to the network:



- Possible to obtain locations that are close to optimal w.r.t. patient volume and continuity of access.



- Location decisions are generally very robust w.r.t. data impreciseness.

- Optimality gap when randomly drawing "true" parameter values:

Optimality gap (25 draws)	Impreciseness				
	10%	20%	30%	40%	50%
Avg. (%)	0.17	0.49	0.75	1.65	1.57
Max. (%)	0.73	1.77	2.73	6.90	8.32
Worst Case Bound (%)	1.35	9.35	20.7	32.8	46.42

- Synergy effects by placing multiple facilities

- Network planning is very beneficial

COMPUTATIONAL RESULTS

- The location problem is Strongly NP-Hard
- The majority of the binary variables can be relaxed by total unimodularity of the corresponding constraint matrix
- Network structure strongly affects solution time

TRUCK DRIVERS IN SUB-SAHARAN AFRICA

Difficult work environment

- Stress, loneliness
- High-risk sexual behavior
- Vulnerable to HIV, STIs, Tuberculosis, Malaria, ...

Traditional health system

- Difficult to access for truck drivers
- Insufficient parking space
- Opening hours
- Truck drivers don't deviate

NORTH STAR ALLIANCE

Roadside Wellness Centers (RWCs)

- Clinics placed at busy truck stops: hotspots
- 34 RWCs in 12 countries in SSA
- Reduce barriers to access

5 service packages

- Primary care services
- STI, Malaria, Tuberculosis, & HIV services

