Phased Development of the Automated Demand Response Feeder Transit System in Rural Areas

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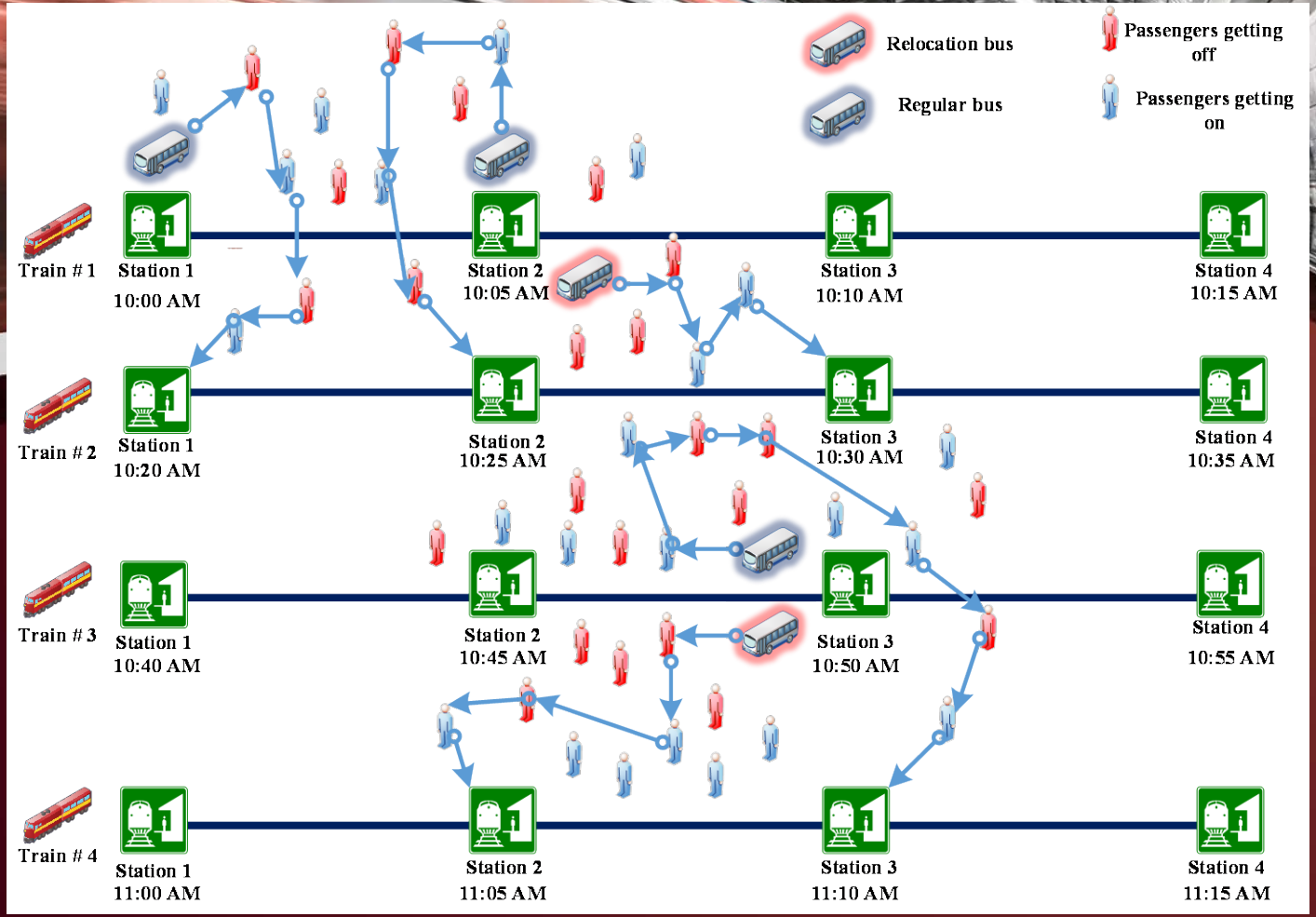
- Once automated vehicles become available:
  - Small-sized flexible door-to-door feeder bus operation will become more realistic
  - Users’ travel behaviors and modal choices will become completely different

- Innovations of proposed automated demand-responsive feeder bus transit system:
  - Considering relocation of feeder buses for multi-stations
  - Considering individual passengers' travel times



Conceptual operation of feeder transit (regular and relocation buses)

Objectives of the research:

- Suggesting a practical framework for phasing an Automated Demand-Responsive Feeder Transit (ADRFT) service project
- Solving a Resource Constrained Project Scheduling Problem (RCPSP) by using Simulated Annealing (SA) algorithm for construction phases of an automated feeder transit system for suburban and rural areas
- Finding out the importance of each phases by conducting a sensitivity analysis

Activity and time data for the project

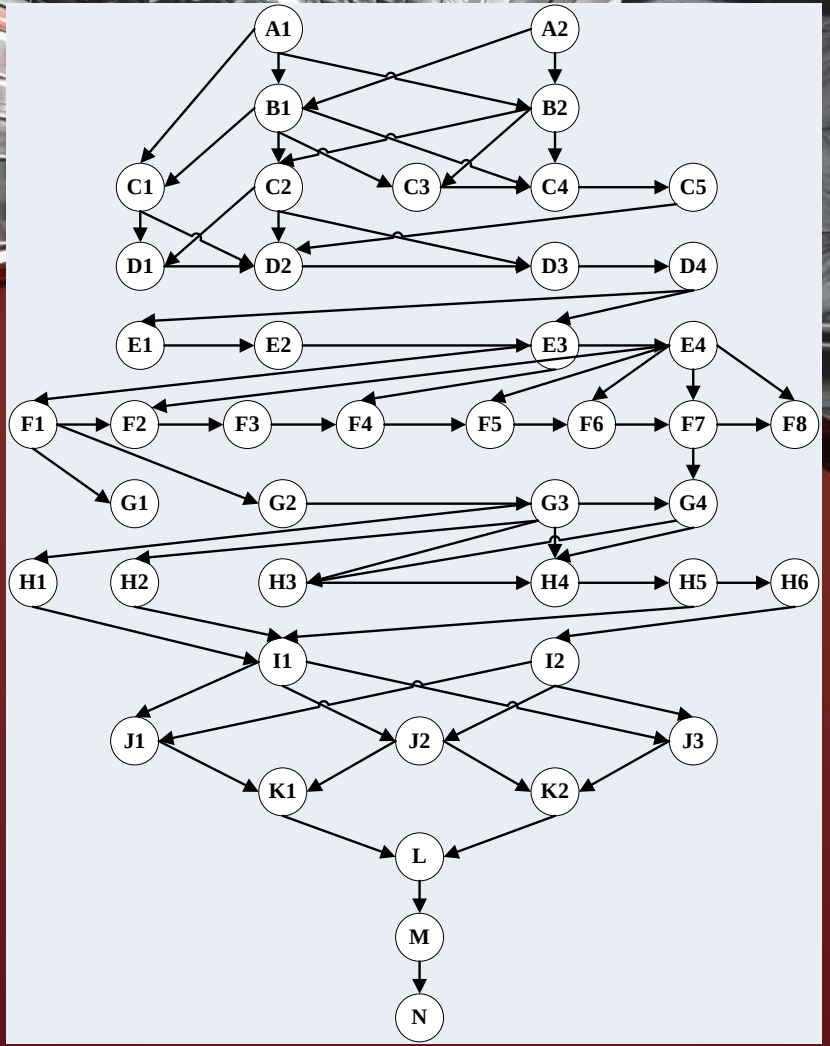
Code	Major Tasks	Minor Tasks	Time units	Prerequisite
A1	Reviewing Regional ITS Architecture	Primary studies	45	
A2		Reviewing upstream plans/projects	30	
B1	Concept Exploration	Feasibility studies	65	A1, A2
B2		Primary cost and benefit estimations and related administartive processes	70	A1, A2
C1	Feasibility Study	System Engineering & ConOps	60	A1, A2
C2		Setting MOEs	70	A1, A2
C3		Detailed Benefits study	50	B1, B2
C4		Detailed Benefits implementation period	55	B1, B2
C5		Connected Automated Vehicle (CAV) procurement	50	C3, C4

Code	Major Tasks	Minor Tasks	Time units	Prerequisite
D1	Systems Engineering Management Planning	Designing master plans	60	C1, C2
D2		System design	65	C1, C3,C5
D3		Budget planning	75	D1,D2
D4		Documentation of the project	55	D1,D2
E1	Hardware Requirements	Designing stakeholder of the project	75	D4
E2		Examinating required elements for hardware and software	55	E1
E3		Desigining a Server database	65	E1,E2
E4		Examinating required configuartion with software and app	85	E1,E2
F1	Software Requirements in High-Level Design	Central software design	45	E3,E4
F2		App development for passengers	50	E3,E4
F3		Phone App development	75	E3,E4
F4		Building Server database	45	E3,E4
F5		Developing routing algorithm	40	E2
F6		Developing App for the Vehicle	65	E3
F7		Communication test between apps, algorithm and database	55	F1
F8		Developing securing, monitoring and controling software	50	F1

Code	Major Tasks	Minor Tasks	Time units	Prerequisite
G1	Hardware and Software Purchasement	Communication devices between buses and servers	55	F1
G2		Producing required hardware stuff	45	F1
G3		On-board navigation and routing units	50	G1, G2
G4		NFC device to check passengers	40	G1, G2
H1	Hardware Installment and Procurement	Installing ITS devices in buses	65	G3, G4
H2		Installing communication device	70	G3, G4
H3		Installing app	65	G3, G4
H4		Installing NFC device to check passengers	55	G3, G4
H5		Setting up sever database	55	H1, H2, H3, H4
H6		Installing securing, monitoring and controling infrastructures	60	H1, H2, H3, H4
I1	Hardware and Softwar Configurartion	Configuring Apps and server database	65	H5, H6
I2		Configuring wireless network infrastructure	50	H5, H6

Code	Major Tasks	Minor Tasks	Time units	Prerequisite
J1	Field Testing	Testing App	50	I1,I2
J2		Testing feeder bus	50	I1,I2
J3		Testing controling and managining system	50	I1,I2
K1	Training and finalizing human-base	Training dispatchers	40	J1,J2,J3
K2		Training repairers	40	J1,J2,J4
L	Subsystem Integration and Verification		65	K1,K2
M	Initial System Deployment and System Validation		75	M
N	System Validation		85	N

- Activity Precedence (AON) Diagram



Conceptual formulation for the RCPSP

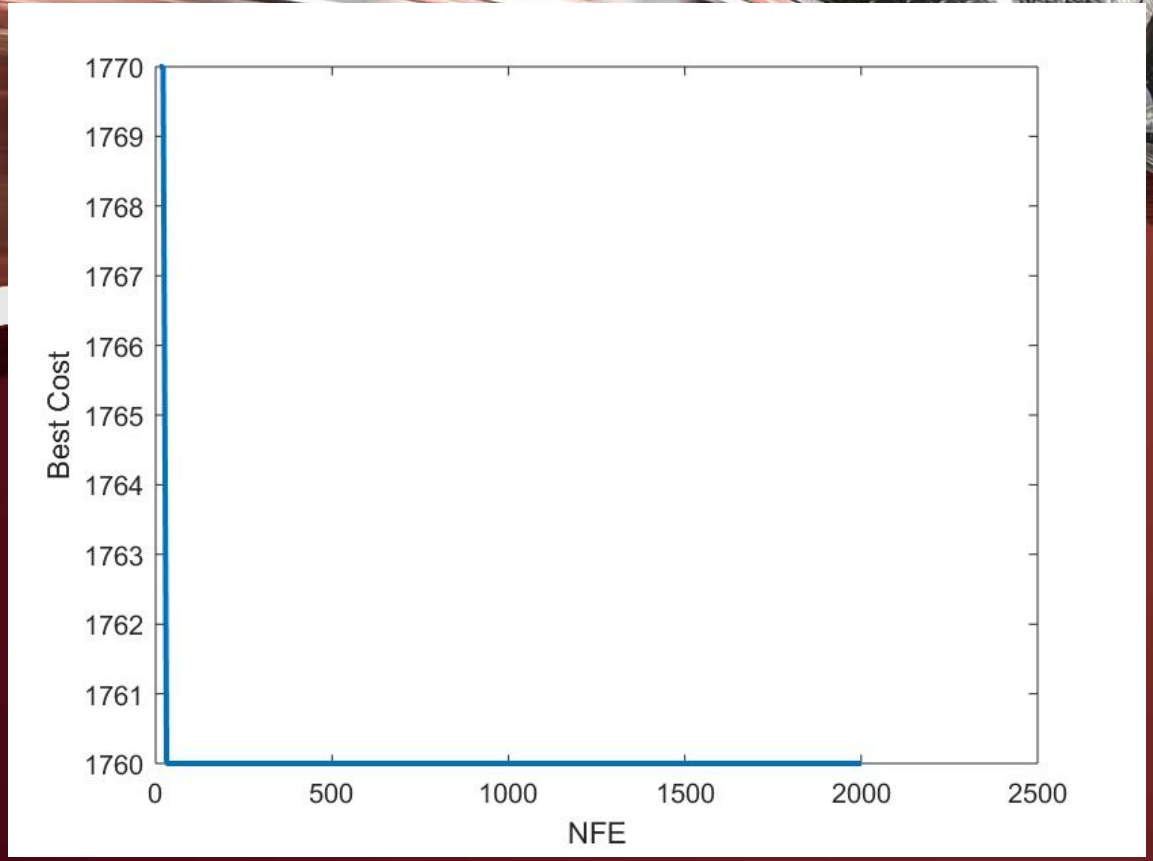
$$\text{Min } S_n$$

Subject to

$$S_i + d \leq S_j$$

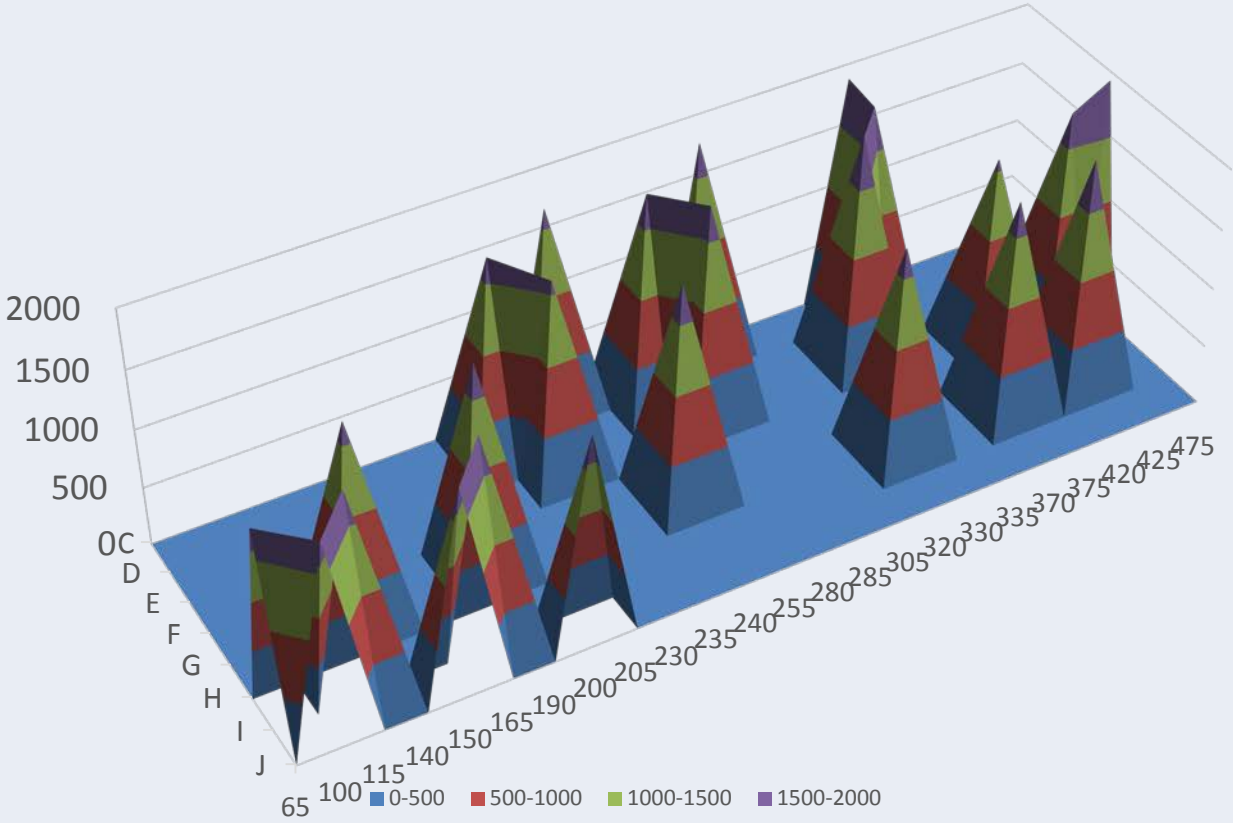
$$S_j \geq \max\{FT_j \mid i \in PL_j\}$$

$$S_i \in \text{int}^+$$



Objective function value vs SA iteration

Sensitivity Analysis



Results:

- We suggested a framework for phasing an automated demand-responsive feeder bus transit system
- A RCPSP has been solved successfully for suggested transit system in rural areas
- Two phases of “Software Requirements in High-Level Design” and “Hardware and Software Purchasement” have shown more sensitivity to time variations

Thank you

Question?