TASK ORDER NO. 01

TASK ORDER NAME: Simulation and Operations Planning
PROJECT CODE: MSP243 ACCOUNT #40-3243.68912

This is Task Order No. 01 to the FrontRunner Next Steps Strategy: On Call Operations Planning and Simulation Assistance entered into by and between Utah Transit Authority (UTA) and DB Engineering and Consulting USA, Inc. (Contractor) as of 01/12/2021.

This Task Order is part of the On Call Operations Planning and Simulation Assistance Contract and is governed by the terms thereof.

The purpose of this Task Order is to specifically define the scope, schedule, lump sum price, and other terms applicable to the work identified herein.

UTA and Contractor hereby agree as follows:

1.0 SCOPE OF SERVICES

The scope of work for the Task Order #01 has been determined to be within the scope of the master FrontRunner Next Steps Strategy On Call Contract and is hereby attached and incorporated into this Task Order.

2.0 SCHEDULE

The Final Acceptance Date for this Task is 05/31/2021.

3.0 LUMP SUM PRICE

The price for this task order is a not to exceed $179,856.44 which will be paid on a lump sum basis once the task is completed and accepted by UTA.

4.0 APPLICABILITY OF FEDERAL CLAUSES

This Task Order does ☐ does not ☒ [Check Applicable] include federal assistance funds which requires the application of the Federal Clauses incorporated to the FrontRunner Next Steps Strategy Contract.

IN WITNESS WHEREOF, this Task Order has been executed by UTA and the Contractor or its appointed representative

UTAH TRANSIT AUTHORITY:

By: Carolyn M. Gonot 1/15/2021
Carolyn M Gonot, Executive Director Date

> $100,000

By: Mary Deloretto 1/14/2021
Mary Deloretto, Chief Service Dev. Officer Date

< 100,000

By: Manjeet Ranu 1/14/2021
Manjeet Ranu, Director of Capital Projects Date

< $50,000

By: Kerry Doane 1/14/2021
Kerry Doane, Project Manager Date

< $10,000

Mike Bell 1/14/2021
Legal Review

Brian Motes 1/14/2021
Procurement Review

DB ENGINEERING & CONSULTING USA INC.:

By: David Hüffmeier 2021.01.20 13:20:11 -08'00'
David Huffmeier, Chief Financial Officer

Date: _____

By: Mark Evans C=US CN=Mark Evans OU=President & CEO E=mark.evans@deutschebahn.com O=DB Engineering and Consulting USA Inc. 2021.01.20 15:01:16 -08'00'
Mark Evans, Chief Executive Officer

Date: _____

UTA – Simulation and Operations Planning
Task order 1

DB Engineering & Consulting USA, Inc.
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October 09, 2020

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1 Overview FrontRunner Service and Ops Analysis: Task Order 1

DB Engineering & Consulting USA Inc (DB), as requested by Utah Transit Authority (UTA), has developed the following scope of work in response to *Task Order 1 – Existing Operating Conditions, Model Development, and Short-Term Operating Scenarios Exploration,* provided to DB by UTA on December 29, 2020.

The primary objective of this study is to develop operationally feasible concepts that allows UTA to expand service in the peak operating periods. In support of that primary objective, there are several sub-objectives that need to be addressed during the planning process:

- Development of appropriate operational parameters within which the service plans will be developed;
- Development of integrated service goals and service approaches;
- Understand the existing and future rail market potential within the FrontRunner Corridor.

DB's approach

A Technical Working Group (TWG) will be formed specifically for this study. The TWG will meet regularly to define the study's objectives, discuss input needs, analyze results, and identify potential concept refinements.

DB uses an iterative process to develop service concepts consisting of a select network configuration and set of stopping patterns and frequencies that meet one or more service goals. These concepts are reconciled to be free of operating conflicts and illustrated with stringlines and netgraphs for discussion and review with a technical working group. The iterative process may also identify operational parameters and/or infrastructure investments that impede achieving the service goals as defined. This analysis is highly iterative with multiple interactions with the working group during this development phase.

We conduct planning-level service and operations analysis with Viriato. Viriato is an integrated timetable planning tool that enables a planner to visualize and assess service, operations, and infrastructure elements of the rail system. It features, a netgraph to develop service concepts, an interactive string line chart to plan capacity usage on a given line, a track/platform occupation chart to plan train turns and storage, and an equipment rotation planner to assess the fleet requirements and maintenance cycles. Using these functionalities, Viriato allows the rapid assessment of multiple concepts and gives the user direct control over service, operations, and infrastructure planning.

1.1 Proposed Tasks

This work effort will be structured in Three Tasks. Task 1 will address the primary objective of this study and will proceed on an accelerate timeline to meet the schedule constraints of the UTA imposed by the legislative calendar. Tasks 2 and 3 will proceed in parallel and develop tools and analysis to support more in-depth planning in future phases.

- Task 1 – Future Service Concept Development: DB, working with the TWG, will develop operationally feasible plans that identify infrastructure investment and/or operational adjustments that allow for increased service during peak periods.
- Task 2 – Operations Analysis / Robust Parameter Development: DB will analyse longitudinal data sets and engage with the operating department of UTA to understand operational issues and how day-to-day variations in operations are handled and could be optimized. This Task will also develop planning parameters rooted in existing operating conditions for future planning tasks.
- Task 3: Simulation Model Development: DB will develop and calibrate a RailSys dynamic simulation model of the Front Runner corridor, to be used in future task orders.

2 Task 1: Future Service Concept Development

Task 1 will be organized in three sub-tasks:

- **Task 1.1: Kick-Off / Planning Parameters / Database Updates**

  Working with the TWG, DB will define a set of service planning goals and operational and infrastructural parameters. These parameters will set the goals and boundary conditions for service, operations, and infrastructure within which the initial service concepts will be defined. These parameters include but are not limited to:

  - Passenger / Service - Peak and off-peak frequency goals, service goals by train type (e.g. local only service or introduction of express trains, etc.), station hierarchy definition (for differentiation by service type), passenger convenience and legibility, connectivity, travel times;
  - Operations / System Performance - System headways, dwell times / terminal turn times, rolling stock types (DMU, EMU, diesel-hauled, etc.), recovery times, general operating rules (e.g. train priority at meets), equipment rotation, maintenance cycles and availability.

  In this step, DB team will develop a Viriato database based on track charts provided to DB by UTA. DB will require existing track charts (already received) and the most recent Employee Timetable that governs operations on the corridor.

  Deliverables: Task 1.1

  - Planning Parameters
  - Viriato Database

- **Task 1.2: Concept Development**

  The Service Concept Development task will use an iterative process to develop service concepts consisting of a select network configuration and set of stopping patterns and frequencies that meet one or more of the service goals and/or emphasize service to certain travel markets. These concepts will be reconciled to be free of operating conflicts and illustrated with stringlines and netgraphs for discussion and review with the working group. The iterative process will also identify operational parameters and/or

infrastructure investments that impede achieving the service goals as defined. This is the key step in the analysis and is highly iterative with multiple interactions with the TWG during this development phase.

Multiple service concepts will be developed by DB in Viriato representing a range of outcomes envisioned for the future Front Runner service. As trade-offs among service, operations, and infrastructure are identified during the planning process, they will be documented and presented to the TWG. Two key areas of interaction and input/feedback from the working group are critical – the acceptability or service adjustments as we adjust the service to fit within the operation and infrastructure constraints; and the feasibility of potential infrastructure changes to reflect the needs of the service and operation plan.

Concepts to be explored in this phase include but are not limited to:

- Future Baseline – including Vineyard Station;
- Added "tripper" trains in each peak period from the both ends of line to Salt Lake City (effectively 15-minute frequency in the peak) stopping at every station;
- Skip stop "express" service in each peak period from both ends of line to Salt Lake City;
- Increase maximum speed to 90mph where possible – could include some recommendations for capital investments to increase the allowable length of corridor that can be run at that speed;

Deliverables: Task 1.2

- Peak-period service concepts including associated technical outputs as appropriate to describe and depict the concept (stringline, netgraphs, and/or customer timetables);
- Documentation of trade-offs among network configurations, service, operations, and infrastructure options.

- **Task 1.3: Concept Refinement**

DB will develop up to three concepts that combine elements of MAS, capacity, equipment, and service changes for final consideration by UTA. Final concepts will identify investment needs by location and include full day timetables and equipment needs.

Deliverables: Task 1.3

- Service concepts including associated technical outputs as appropriate to describe and depict the concept (stringline, netgraphs, and/or customer timetables);
- Capital project list identifying locations of double tracking needs to operate each concept;
- Required equipment - type and amount - for each concept.

3 Task 2 – Operations Analysis / Robust Parameter Development

Gathering a clear picture of existing operations and identifying and understanding root causes of delay will help UTA make cost effective decisions to drive improvement. In Task 2, DB will perform root cause analysis of service delays by cause, location, duration, and trains involved. DB will analyse UTA data from sources such as delay reports, signal system logs, and/or GPS tracking data to identify causes of delays. Data visualization tools such as Tableau allow us to mine this data for trends. We will also use the rail-specific data tool TRENOanalysis which allows us to visualize train performance in stringline format. TRENOanalysis can recreate actual train performance on a specific day or show trends over a multiple-day period. Combined, these two tools allow DB E&C to generate the baseline insights on current performance and causes of delay. This analysis will also allow UTA to validate and/or update planning parameters used in Task 1 for future planning tasks.

Task 2 will be organized in three subtasks.

- **Task 2.1: Data Collection**

  DB will work through the TWG to identify data needs for analysis - signal data, event recorder, and/or GPS data and work with the UTA operations team to receive and process data for analysis.

  Deliverables: Task 2.1

  - Databases cleaned and organized for analysis in Tableau and Treno

- **Task 2.2: Analysis of Existing Operations (Treno)**

  DB will build a Treno Database based on the data gathered in Task 2.1 and assess operations against the timetable. This analysis will include the performance of actual operations of point-to-point run times, meets and turns against the plan.

  Deliverables: Task 2.2

  - Presentation materials including slide decks, tables, and/or other technical materials as needed to share at each bi-weekly Technical Working Group meetings
  - Treno database

- **Task 2.3: Recommendations, Updated Parameters**

  DB will develop a set of recommendations for adjustment to existing operations to optimize service and reduce systemic delay in the short term. DB will also develop a set of parameters for use in future planning tasks including appropriate planning allowances for dwells, meets, turns, and trailing headways.

  Deliverables: Task 2.3

  - Presentation style report describing recommended adjustment to existing operations;
  - Robust planning Parameters - dwells, meets, turns, and trailing headways.

4 Task 3 – Simulation Model Development

DB will develop a dynamic simulation model in RailSys for use in future task orders. Dynamic simulations will be conducted when service concepts are fully developed in Viriato and selected by UTA. A baseline dynamic simulation model will include more details of the infrastructure than Viriato and will be calibrated to emulate the existing operations. The reliability of the concept developed in Viriato will be evaluated by introducing random service disruptions. Minor disruptions of daily operation will be simulated based on the agreed perturbations as directed by the TWG (e.g. run time variation, entry delay, dwell time extension, etc.). The simulation tool allows the user to define the distribution of parameters used for perturbation to match the expected level of disruption.

Task 3 will be organized in three sub tasks.

- **Task 3.1: Data Preparation**

  DB will create an excel workbook to organize data for input into RailSys. These data include:

  - mainline speed track speeds limit
  - turnout location and speed limits
  - mainline grades
  - station locations and configurations
  - signal location and signal aspects as per interlocking inputs
  - train performance curve / braking rates / length and weights

  DB will require detailed information in order to develop the needed dataset on which code the simulation model. In addition to the track charts and employee timetables needed for Tasks 1 and 2, DB will require signal aspect charts for the corridor.

  Deliverables: Task 3.1

  - Excel workbook containing all infrastructure elements to be coded into RailSys

- **Task 3.2: Model Coding (infrastructure + rolling stock)**

  DB will code alignment data, signalling system data, and rolling stock into the RailSys Infrastructure module.

  Deliverables: Task 3.2

  - Preliminary RailSys model.

- **Task 3.3: Model Calibration**

  DB will calibrate the RailSys model to accurately reflect existing operations. This Task will define the detailed data necessary for this calibration - for example, route setup time, route release time and signal sight distance for train engineers as well as primary

vs secondary routing assignments through the network. In addition, DB will also calibrate the parameters for rolling stock such as standard coasting time, maximum braking rate, and coach loading to ensure run time are accurately calculated. DB will perform runtime simulations and compare those with existing station-to-station travel times from locomotive event recorder data.

DB will work with the Technical Working Group to ensure all the parameters in the RailSys model are accurately defined and reflects the operations in terms of how UTA dispatches its trains before any simulation commences to ensure reliable simulation outputs.

Deliverables: Task 3.3

- Fully calibrated RailSys model

5 Estimated Project Schedule

The following estimated project schedule is proposed. Weekly interactions with the Technical Working Group are assumed throughout the project.

DB is responsible for timely development of materials and will ensure best efforts to coordinate with UTA and other stakeholders as needed to deliver outlined scope above.

Week Of -->	18-Jan	25-Jan	1-Feb	8-Feb	15-Feb	22-Feb	1-Mar	8-Mar	15-Mar	22-Mar	29-Mar	5-Apr	12-Apr	19-Apr
Task 1: Future Service Concept Development														
1.1 Kick-Off / Planning Parameters / Database Updates														
1.2 Concept Development														
1.3 Concept Refinement														
Task 2: Operations Analysis / Robust Parameter Dev.														
2.1 Data Collection														
2.2 Analysis of Existing Operations (Treno)														
2.3 Recommendations, Updated Parameters														
Task 3: Simulation Model Development														
3.1 Data Preparation														
3.2 Model Coding (infrastructure + rolling stock)														
3.3 Model calibration														

6 Estimated Level of Effort - Budget

DB E&C reserves the right to reassign work hours among the project team, as required, to fulfil the scope of work for this task. If complexity is beyond the anticipated level, additional budget may be necessary to complete this effort.

	Principal Consultant	Managing Consultant	Consultant	Analyst	Total Effort	Total Budget
	$294.55	$228.78	$147.07	$130.73		
Task 1: Future Service Concept Development	88	88	0	164	340	$67,492.76
Task 2: Operations Analysis / Robust Parameter Dev.	144	0	0	200	344	$68,561.20
Task 3: Simulation Model Development	20	0	176	92	288	$43,802.48
Total	**252**	**88**	**176**	**456**	**972**	**$179,856.44**