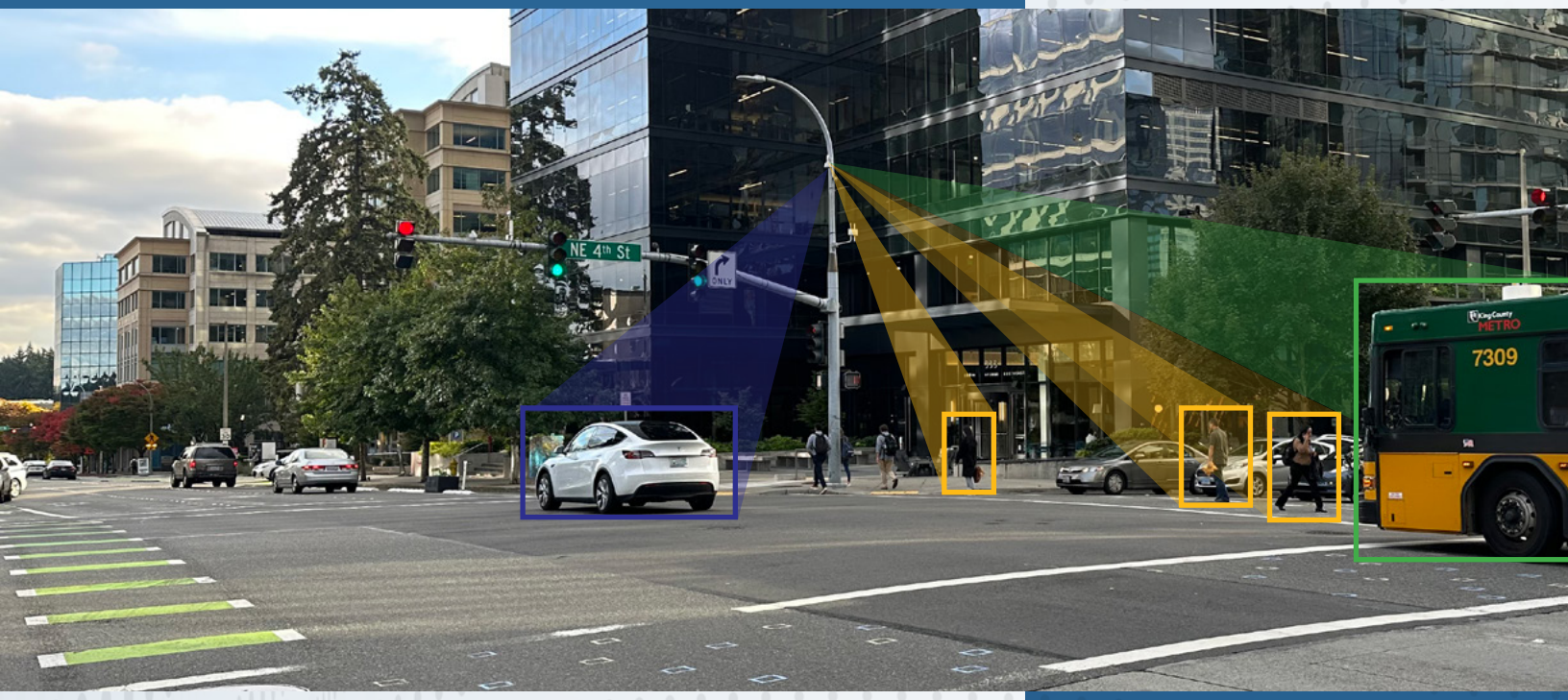
Real-Time Traffic Signal Safety Interventions (RTSSI) Project



October 10, 2023

Submitted by:
City of Bellevue
UEI#: DQ3JYJ78JMD5

In Partnership with:

Strengthening Mobility and Revolutionizing Transportation (SMART) Stage 1 Planning and Prototyping

GRANT APPLICATION

(DOT-SMART-FY23-01)

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1. OVERVIEW/PROJECT DESCRIPTION

The City of Bellevue is seeking a $1.43 million Stage 1 SMART grant to improve safety at signalized intersections, within the majority-minority community called Crossroads. Bellevue's Real-Time Traffic Signal Safety Interventions (RTSSI) project integrates intelligent sensor-based infrastructure with smart technology traffic signals to improve safety for all modes at signalized intersections. The RTSSI project will prototype the use of intelligent sensors, video analytics, deep learning, and edge computing to proactively detect safety risks for vulnerable road users (VRUs) and apply real-time traffic signal safety countermeasures.

1.1 Real World Issues and Challenges Addressed

Vulnerable Road User Safety at Intersection Crossings: Over half of all fatal and serious injury crashes in Bellevue involve a VRU with 21% of these collisions resulting in a fatality. Existing traffic signal control systems have little to no capability to mitigate prevailing VRU risks in real-time. Local community-based participatory design sessions revealed that traffic signals are not sensitive to the needs faced by travelers living with mobility limitations, older adults, and multi-generational households.

Vehicle-Centric Operations at Signalized Intersections: Traffic signal systems deployed throughout the U.S. use detection technologies and timing strategies optimized for vehicular throughput. This results in static treatments for other modes that can leave people walking and rolling stranded in the crossing, missed detection for bicyclists, and failure to yield to pedestrian conditions.

1.2 Proposed Technologies

Intelligent Sensor-Based Infrastructure: Video analytics, LiDAR, deep (machine) learning, and edge-computing technologies are proposed to detect and classify roadway users to compute risk factors. These computations will trigger real-time safety interventions with the traffic signal controller system.

Smart Technology Traffic Signals: This Stage 1 project will enhance traffic signal control systems by introducing real-time safety intervention strategies for VRUs. Inputs received from the intelligent sensor-based infrastructure will integrate with traffic signal controller operations. The proposed safety use cases include: Dynamic Extension of Pedestrian Walk Times, Passive Pedestrian Detection Phase Extension, Dilemma Zone Protection, Dynamic Left Turn Phasing Operations, and Dynamic "No Right Turn on Red."

As an illustrative example, this project will flag instances where a pedestrian has not completed crossing within the time allotted for the established walk interval. In this scenario, the system will intervene – providing notification to Bellevue's traffic signal controller cabinet to extend the crossing phase and hold any conflicting vehicle phases until the person is safely across.

1.3 Desired Outcomes for Stage 2 Grant

Stage 2 will incorporate the lessons learned from Stage 1 and demonstrate how government infrastructure owners and operators (IOOs) can scale and implement the proposed technologies. Outcomes are anticipated to include:

1. Expanding and scaling the proposed technologies to the City of Tacoma, a key partner in Stage 2. Bellevue and Tacoma represent the two largest metropolitan areas in the Puget Sound region outside of Seattle.
2. Provide and quantify safety improvements.
3. Demonstrate economies of scale when technology is deployed at scale.

1.4 SMART Grants Program Goals Alignment

In Stage 1, the project will implement the RTSSI pilot and evaluate safety effectiveness in the Crossroads community. This project fosters strong public-private partnerships, which includes collaboration with non-government organizations, academia, and public agency partners to co-design systems that will make a profound impact towards transportation safety. Successful demonstration of this project will provide validated safety countermeasures and strategies for practitioners to utilize.

1.5 Improvement of Transportation System Status Quo

The RTSSI Project will improve the status quo through:

Safety Awareness – provide visibility of safety issues at signalized intersections.

Multimodal Signal Operations – detect all roadway user types at signalized intersections, especially those with mobility challenges.

Safety Intervention – initiate real-time safety interventions based on detected risks.

Partnerships and Workforce Development – collaborate and share knowledge with the industry to re-envision how traffic signal systems can be optimized to improve safety.

Figure 1: Study Area

2. PROJECT LOCATION

The City of Bellevue (2020 Census-designated urban area) is a mid-sized community located within King County, Washington. The Stage 1 project will be implemented within the Crossroads community consisting of five census tracts. Two of the five tracts are identified as Historically Disadvantaged Communities (HDCs) per the criteria of transportation safety (0237.02) and workforce development (0232.02).

The project will plan and implement technology at five signalized intersections (Figure 1). The study area was selected based on historical data involving VRU collisions, and the opportunity to study multiple safety intervention use cases. Within the project boundaries, the pedestrian focused BelRed light rail station, along with the presence of schools, parks, and major shopping destinations, underscores the urgency of improving multi-modal safety and transportation infrastructure.

3. COMMUNITY IMPACT

The City of Bellevue is recognized as the region's largest majority-minority city. Over 43% of residents speak a language other than English at home. According to USDOT's Screening Tool for Equity Analysis of Project (STEAP), this statistic is pronounced in Crossroads where 61% of the residents speaks a language other than English at home. STEAP also indicates that 54% of the population in Crossroads identify as an ethnic minority race. Bellevue has also chosen Crossroads to prototype the RTSSI project because it will benefit a significant older community (25% of the population is 65 years old or older), with an estimated 13% of the population reporting as having a disability. More than half of residents residing near Crossroads are seniors and children under 18.

Bellevue has formed a partnership with the City of Tacoma for wide-scale deployment in Stage 2, following the successful completion of Stage 1. Thirteen census tracts within Tacoma are identified within an area of Persistent Poverty. The entirety of Downtown Tacoma is identified as a HDC. Additionally, 75% of the High-Risk Network in Tacoma is located within an area with an Equity Index of low or very low. The City of Bellevue anticipates that scaling the proposed technology to the City of Tacoma in Stage 2 will demonstrate high community impact where disadvantaged populations are disproportionately impacted by traffic violence.

4. TECHNICAL MERIT

4.1 Technical Merit Criterion #1: Identification and Understanding of the Problem to be Solved

4.1.1 Project Understanding. According to data from the National Highway Traffic

Safety Administration (NHTSA), fatalities at intersections represent 27% of all road traffic deaths in 2020. In Bellevue, signalized intersection collisions make up a majority of the fatal and serious injuries. Most fatalities and serious injuries among people walking and bicycling in Bellevue occur at intersections: 61 percent of pedestrian and 54 percent of bicycle fatalities and serious injuries. Bellevue's RTSSI project aims at reducing a significant share of fatal and serious collisions in an urban environment.

4.1.2 Problem Criticality. This project acknowledges that growing rates of roadway fatalities and serious injuries cannot be reversed without proactive systems enabled to intervene when a high risk is detected, aligning with the Safe System approach. For example, in 2021, Bellevue utilized machine learning and video analytics to conduct a Leading Pedestrian Intervals (LPI) pilot at signalized intersections – resulting in 42% reduction in vehicle-pedestrian conflicts post-implementation. These results demonstrate that complex intersection safety challenges can be mitigated with proposed RTSSI technologies.

Data obtained from Bellevue's Collision Dashboard indicates that 53% of all pedestrian fatalities and serious injuries are related to failure to yield from drivers of motor vehicles. Bellevue's RTSSI project strives to reduce these statistics by implementing proactive safety countermeasures at signalized intersections which pose a disproportionately higher risk to VRUs using the roadway network.

The RTSSI use cases were developed based on actual collisions that have resulted in fatalities or serious injuries in Bellevue. For example, in 2021, an elderly couple was crossing at one of the selected project intersections proposed in Stage 1. Due to mobility limitations, the elderly couple was not able to cross within the allotted time and was struck by a left turning vehicle making a permissive left turn. Operationalizing the Passive Pedestrian Phase Extension feature, as proposed by RTSSI, would have potentially prevented this crash from occurring.

4.2 Technical Merit Criterion #2: Appropriateness of Proposed Solution

4.2.1 Technical Feasibility. In February 2023, the Federal Highway Administration (FHWA) Joint Program Office released the "Enhancing the Safety of Vulnerable Road Users at Intersection" report. The Report concludes that it is "feasible to develop an intersection safety system for VRUs based on the technologies evaluated in the RFI, specifically including machine vision and sensor fusion." The technologies in Bellevue's RTSSI proposal have been curated to align with these findings to maximize project project effectiveness and feasibility.

The proposed technology meets the FHWA Technology Readiness Level 8. In the past year, Bellevue has successfully piloted sensor-based infrastructure including video analytics, LiDAR sensors, and edge processing at one of our downtown intersections. Results from this small-scale deployment demonstrates that these technologies and types of safety use cases are technically feasible, and can be operationalized.

4.2.2 Scalable. Bellevue's RTSSI approach is focused on making widespread safety impacts in the state-of-practice for traffic signal operations. The proposed technologies will use universal hardware based on national standards, making this project easily replicable in other communities and scalable to other settings. This project will deploy edge-based sensor technologies that will communicate with a universal contact closure-based hardware that is compatible with typical detector input racks found in all traffic signal cabinets deployed nationwide (NEMA and 2070 styles). This approach maximizes portability as the only prerequisite is a traffic signal control system capable of receiving detection inputs.

4.2.3 Impact vs Status Quo. Many government agencies continue to rely on traditional traffic safety approaches. They intervene only after enough crashes reports are filed to trigger a high crash designation. As a result, safety planning and implementation takes multiple years before an improvement is made and deemed effective. The proposed RTSSI technology changes this narrative by using techniques to detect risk factors at signalized intersections and edge-computing capabilities to make decisive real-time safety interventions. The intelligent sensor-based infrastructure will provide additional detection capability that will allow the traffic signal

controller to react to conditions such as slower moving pedestrians, higher volumes of pedestrians, or potential turning conflicts. This dramatically changes the way that a traffic signal system can account for VRU safety.

4.2.4 Contextually Appropriate. The RTSSI project will focus on the Crossroads community in Stage 1 where all signalized intersections are identified on the City's High Injury Network. As mentioned in Section 2, half of the residents near Crossroads are seniors and children under 18. Furthermore, approximately 15% of individuals in these communities do not have access to personal vehicles and 13% of the population report having a disability according to STEAP. The Crossroads Mall is a significant trip generator in the project area and is served by bus rapid transit. The RTSSI informs use cases that account for slower moving pedestrians, as well as sudden increases of people crossing as passengers alight from transit. This technology will help the traffic signal control system be more responsive to the needs of all users, especially VRUs.

4.3 Technical Merit Criterion #3: Expected Benefits

4.3.1 Program Priorities. The project takes a data-driven and proactive approach that is informed by real-time insights at signalized intersections. The following RTSSI Project key benefits align with the USDOT Departmental and Program Priorities that include:

SAFETY & RELIABILITY: Problem-driven safety improvements for people walking, rolling and biking in two ways: 1) real-time changes to signal timing in response to safety issues; and, 2) detection/analytics of near-miss collisions to inform future projects and strategies.

RESILIENCY: A more resilient transportation system that will implement safeguards to prevent serious crashes at signalized intersections, thereby maintaining usability and reliability of the transportation system for all users.

EQUITY & ACCESS: Improves intersection safety for the largest majority-minority community in Bellevue that has a high proportion of the city's aging and disabled populations. Additionally, RTSSI can scale to disadvantaged communities in Tacoma where a majority of the high injury network is found in disadvantaged communities.

PARTNERSHIPS: Bellevue has united key public and private partners to address VRU safety through deployment of RTSSI emerging technologies. Bellevue has a successful track record in delivering safety-driven results in our technology partnerships.

INTEGRATION: Focuses on integration and operationalization of a traffic signal ecosystem that is sensitive to the safety needs of all users using intelligent sensors, video analytics, deep learning, edge computing, and traffic signal control hardware.

4.3.2 Rationale. As described in 4.2.1, Bellevue staff have developed a high degree of confidence that this safety use case can be operationalized in real-time. Bellevue's experience with video analytics, LiDAR sensors, and edge-computing technologies, paired with an adaptive signal control system experience will demonstrate that the envisioned outcomes are possible. Pursuing this project provides a solution to one of the nation's greatest health crises using technologies that are tested and well understood. The use cases defined were derived from real statistics of fatal and serious collisions and Bellevue and the combination of identified technologies is anticipated to solve these challenges.

4.3.3 Performance Measures. Bellevue's traffic signal control system will log all events and operational countermeasures triggered by the RTSSI system without placing the safety features into live action. This allows project staff to evaluate timestamps for each initiated RTSSI event against other data sources, such as recorded traffic camera videos and traffic count data, to assess efficacy and accuracy. Once deemed accurate in Stage 1, we will evaluate and quantify the potential benefit-to-cost in the Stage 2 large-scale implementation. Performance measures include:

- **Number of Collisions** – mode type, time of day, weather conditions
- **Number of Near-miss Conflicts** – mode type, time of day, weather conditions

- **Number of Safety Interventions** – total number of interventions triggered
- **Detection Accuracy** – number and percentage of true positives (correct events), false positives (false events) and false negatives (non-detections)
- **Public Feedback (Survey)** – safety perception and sentiment

5. PROJECT READINESS

5.1 Project Readiness Criterion #1: Feasibility of Workplan

5.1.1 Workplan. Our team is ready to implement the project immediately since this project is a continuation of Bellevue's Video Analytics towards Vision Zero work program. The grant will provide needed resources for Bellevue to accelerate existing efforts, transition to live operations, expand capabilities to additional use cases, and assess safety effectiveness. The city is confident the schedule is reasonable and allocates sufficient time to address amendments to city policy, local regulations, and community input through public engagement activities.

The workplan is sensitive to the optimal time needed to train and optimize the deep learning models for new use cases (60 days/use case). The project workplan anticipates that training and optimization for multiple use cases will occur simultaneously.

Task 1 – Stakeholder Engagement and Public Outreach: This task is a continuation of pre-award activities to finalize partnership agreements, the workforce development plan, and the public engagement plan. From project start to completion, we will involve public engagement staff to maximize project visibility and address community concerns.

Task 2 – Evaluation and Data Management Plan: Project stakeholders will document performance metrics and measurable targets to inform whether the system demonstration meets expectations and if full implementation would meet program goals.

Task 3 – Installation, Configuration, and Testing: Ensures that the system hardware and software complements are integrated thoroughly with bench and field testing. Concurrently, the project team will address public access requirements, perform baseline data collection, and host vulnerable user focus groups to document safety perceptions.

Task 4 – System Demonstration and Evaluation: The demonstration approach will follow a weekly on/off approach to reduce external variances. Data will be collected 24/7 to help quantify the benefits of real-time safety interventions with signal controller operations.

Task 5 – Workforce Development: Provide Bellevue staff and key partners with targeted training sessions and hands on experience in deploying, operating, and maintaining the system. This task will inform scalability of the solution for Stage 2.

Task 6 – Implementation Report: The report will detail the issues and benefits of the technologies and strategies proposed. Following successful Stage 1 demonstration, a draft SMART Stage 2 implementation plan with scope, schedule, and budget will be developed within the Implementation Report.

5.1.2 Regulatory Compliance. The city will establish a regulatory compliance plan prior to grant contracting with the USDOT. Since the project primarily includes equipment installation on existing infrastructure that is fully within existing city right of way, the city intends to follow NEPA Categorical Exclusion (CE) requirements. Additionally, this project will adhere to Buy America Build America equipment certification, vendor and consultant procurement following 2 CFR Part 200, and submit a Public Interest Finding for the use of agency forces for equipment installation. The City of Bellevue's Transportation Department and City Attorney's Office are also experienced in executing End User Licensing Agreements and Master Software Service Agreements with technology firms that address concerns such as data privacy, data retention, intellectual property, data governance, cybersecurity, etc.

5.1.3 Performance Measurement. The Evaluation and Data Management Plan will detail the data collection process, performance metric alignment with project objectives, and cost-benefit calculation assumptions. Bellevue will supplement measurement and validation efforts through public engagement to understand the user perspective. Unique to Bellevue is our Adaptive Signal Control

platform which allows city staff to pilot the RTSSI use cases proposed without triggering into live action. Instances where a safety feature is triggered can be logged in the system with detailed timestamps. Consequently, logs can be compared against live observations for evaluation and performance measurement purposes.

5.1.4 Technical Job Training. The project will include training and education opportunities all project partners including our proposed Stage 2 partner, Tacoma. Bellevue and its partners will receive training on equipment installation, signal timing adjustments, and data visualization tools that will support Stage 1 evaluation requirements and future Stage 2 implementation activities. The project team will organize a Community of Practice and prepared video training content to allow other public agencies to engage with the Bellevue project team to transfer knowledge regarding equipment installation, signal controller configurations, and potential use cases applicable to their jurisdiction.

5.1.5 Project Budget. The budget was developed based on experience and known costs through prior and active technology partnerships. We have developed a good understanding of development level of effort, integration and equipment costs derived from our ongoing technology partnerships with multiple technology companies. Additionally, the project budget, in year of expenditure dollars, accounts for Bellevue staff level of effort and labor rates and anticipates contractual support to fulfill the project workplan.

5.1.6 Quality Jobs. Over the past decade, Bellevue has garnered the attention of safety practitioners nationwide in applying video analytics towards Vision Zero goals. As such, Bellevue has cultivated partnerships with peer cities and practitioners who are eager to learn from our experiences. This project represents a catalyst for a new cohort of safety-minded transportation planners, engineers, and technologists that are adept in applying emerging technologies to solve transportation safety challenges. The new opportunities presented by this project will mimic the breakthrough in near-miss safety data that created an entirely new field of practice and job opportunities within the transportation safety data arena.

5.1.7 Quantitative Measurement and Validation. The project's performance evaluation will be based on quantitative data derived from the intelligent sensor equipment, the traffic signal control system, and existing data sources including Bellevue's KSI Collision Dashboard. Data generated by these sources will be fused, cleaned, and published in easy-to-understand safety metrics, such as near-miss data. These metrics can then be compared against current operations and real-time safety intervention operations to understand and calculate the benefit.

5.2 Project Readiness Criterion #2: Community Engagement and Partnerships

5.2.1 Stakeholder Engagement. Throughout the project life cycle, Bellevue staff will launch and maintain a public engagement campaign involving project stakeholders and the public using a public-facing tool called Engaging Bellevue (www.engagingbellevue.com). The tool is designed to seek feedback from the community through online open houses, surveys, public comments, online handouts, and interactive maps. Engaging Bellevue is powered by a software platform that translates

Table 1: Project Workplan

	2024	2025				2026
Project Quarter	*Oct* Q1	Q2	Q3	Q4	Q5	*Mar* Q6
Task 1: Stakeholder Engagement and Public Outreach	■	■	■	■	■	■
Task 2: Evaluation and Data Management Plan	■					
Task 3: Installation, Configuration, and Testing		■	■	■	■	
Task 4: System Demonstration				■	■	■
Task 5: Workforce Development					■	■
Task 6: Implementation Report				■	■	■

Note - This schedule can advance to assure start within 6 months of award

all published material to over 100 languages. Additionally, the University of Washington Taskar Center for Accessible Technology (TCAT) has committed to supporting Bellevue in hosting a series of focus-group meetings to co-design the RTSSI use cases with the public and assure that the voices and lived-experience of community members impacted by mobility challenges at signalized intersection are heard.

5.2.2 Partnership. Bellevue has delivered successful technology partnerships, particularly in the application of advanced sensors in the field of transportation safety. In 2016, Bellevue launched a Video Analytics Towards Vision Zero program that leverages traffic conflicts analytics. In partnership with the private sector, research institutions, and non-profit organizations, the city used its extensive network of 360-degree, high-definition traffic cameras to identify the frequency and severity of near-crash traffic conflicts between people driving, walking, and bicycling. Since then, Bellevue has engaged with over 15 companies in advancing video analytics work for traffic safety.

A Project Advisory Committee will be established with representatives from Together for Safer Roads, Roadway Safety Foundation, AAA Foundation for Safety, AAA Washington, Insurance Institute for Highway Safety (IIHS), and the UW to provide feedback and insights during the project. Private sector solution providers and technical experts will be contracted to implement the solution, ensure the schedule milestones are met, and evaluate the results. Additionally, the City of Tacoma has been identified as a key future Stage 2 partner to demonstrate technology scalability and portability. In Stage 2, this project has the potential to apply RTSSI safety technologies to 13 HDC communities in Tacoma, which provides a significant positive impact towards transportation safety in these underserved areas.

5.3 Project Readiness Criterion #3: Leadership and Qualifications

5.3.1 Leadership Team. Bellevue staff have become well-versed in the technologies described in this grant through active partnerships over seven years. The technical team is led by Daniel Lai (PE), Bellevue's Smart Mobility Manager. Daniel has over 15 years of specialized experience in deploying, operating and managing Smart Mobility Solutions. Daniel is supported by Franz Loewenherz, Bellevue's Mobility Planning and Solutions Manager, an expert in transportation safety planning and video analytics. Together, Daniel and Franz have co-managed over six technology partnerships that focused on advancing Video Analytics and LiDAR sensor technology for Vision Zero. Notably, under Daniel and Franz's leadership, Bellevue has been recognized nationally for its accomplishments in transportation safety including the 2017 ITE Transportation Achievement Award for Safety, 2021 Roadway Safety Foundation National Roadway Safety Award, 2021 ITE Edmund R. Ricker Award and 2023 T-Mobile Community Impact Award.

5.3.2 Technical Team. Bellevue has partnered with the UW and the IIHS to support evaluation of the RTSSI use cases. The Technical Team will be comprised of:

Dr. Yinhai Wang is a transportation engineering professor at UW, founding director of the Smart Transportation Applications and Research Laboratory, and Director for the Pacific Northwest Transportation Consortium at UW. His active research fields include traffic sensing, Artificial Intelligence methods and applications, transportation safety, traffic operations and simulation, and smart urban mobility which directly align with the technical needs of this project.

Dr. Anat Caspi is a Principal Scientist at the UW TCAT and focuses on developing accessible technologies that benefit individuals with motor limitations and speech impairments. Dr. Caspi will support RTSSI through co-design of the described use cases such that they are useful and effective for individuals that live with mobility challenges.

Dr. Raul Avelar is a distinguished Senior Research Engineer at the IIHS. Dr. Avelar has held positions at Oregon State University, Texas A&M Transportation Institute, and now IIHS. His career focus has been on evaluating the efficacy of roadway safety countermeasures. He has been involved in many nationally recognized publications for the FHWA.

Appendix I: Resumes

Daniel Lai, PE

Project Manager

Daniel brings over 15 years of US and international experience in Smart Mobility and ITS planning, design, and operations. Daniel is the Smart Mobility Manager at the City of Bellevue and oversees the implementation of transportation technology projects. Recently, Daniel has been involved in deploying, operating and testing video-analytics, LiDAR and edge-computing based systems in Downtown Bellevue to support Passive Pedestrian Detection safety use cases. This effort directly aligns with the project proposed in the RTSSI project. Daniel is also actively engaged in advancing the state-of-practice for multimodal sensor and traffic signal technologies to enhance transportation safety and Vision Zero. He has participated in multiple award-winning technology partnerships within these focal areas within his six-year tenure at the city.

At Bellevue, Daniel manages an annual capital budget of approximately $1.2M, which funds the operations of the city's adaptive signal control system, citywide fiber optic system, multimodal transportation data platforms, transit technology initiatives and technology planning efforts. Daniel is also the author of the city's Smart Mobility Plan and Autonomous Vehicle Strategic Vision. Daniel was also the past President of the ITE-Washington State Chapter and was recognized by ITE International as a 2021 Young Leader to Follow.

B.S. Civil Engineering
University of British Columbia, 2009

Franz Loewenherz

Deputy Project Manager

Franz brings over 30 years of transportation planning experience overseeing multi-disciplinary teams.

Franz is the Mobility Planning and Solutions Manager at the City of Bellevue. In this role he leads a team that advances Vision Zero road safety, pedestrian and bicycle infrastructure implementation, municipal-transit collaborations, emerging mobility technologies, and data collection and analysis systems.

Franz has a demonstrated track record of success establishing/managing partnerships with technology companies and researchers to develop proactive road safety solutions that leverage video and LiDAR, artificial intelligence, cellular-vehicle-to-everything, and cloud/edge compute systems.

Franz's work implementing safety solutions has been recognized with a 2022 USDOT National Roadway Safety Award, 2017 ITE Transportation Achievement Award for Safety, 2016 USDOT Mayor's Challenge for Safer People, Safer Streets Award, and a 2012 FHWA/FTA Transportation Planning Excellence Award.

Franz is a member of the National Academies of Sciences Transitioning Evidence-based Road Safety Research into Practice Committee.

MUP. Transportation Planning
University of Washington, 1992

Raul Avelar, PE, PhD, PMP

Senior Research Transportation Engineer, IIHS

Raul Avelar is senior research transportation engineer at the Insurance Institute for Highway Safety since 2023. Raul's expertise spans highway safety and design, roadway operations, traffic control devices, bicyclists and pedestrian treatments, and technical assistance and implementation to agencies with safety projects. Prior to joining IIHS, Raul was the Roadway Safety Program Manager at the Texas A&M Transportation Institute, where he led or played key roles in multiple safety-focus transportation projects for federal and state stakeholders. Sample projects related to his proposed support role in this grant include: development of a safety score and implementation tool for TxDOT to help decision making in transportation project projects in 2020; support to TxDOT identifying risk locations for roadway departure through systemic analysis in 2020; and a robust evaluation of the safety effectiveness of adaptive signal control systems for FHWA in 2021.

Raul is a Project Management Professional certified with the Project Management Institute, a Professional Engineer registered in the state of Texas, and past president of the Brazos Valley ITE Section in Texas (2019).

Ph.D. Civil Engineering
Oregon State University, 2012

Yinhai Wang, PhD, PE, Dist.M.ASCE, F.IEEE

Academic Technical Advisor

Dr. Yinhai Wang is a professor in transportation engineering at Civil and Environmental Engineering and adjunct professor at Electrical and Computer Engineering of the University of Washington (UW). He has served as director for Pacific Northwest Transportation Consortium (PacTrans), USDOT University Transportation Center for Federal Region 10, since 2012. Dr. Wang was an elected governor for the IEEE Intelligent Transportation Systems Society (ITSS) from 2011 through 2013 and served as the 2018-2019 president of Transportation & Development Institute (T&DI) and founding co-chair of the Connected and Automated Vehicle Impact Committee (2017-2022) at American Society of Civil Engineers (ASCE). He currently serves as the chair for the Artificial Intelligence (AI) and Advanced Computing Applications Committee of the Transportation Research Board (TRB) and vice chair for the ASCE Committee on Technical Advancement. His active research fields include traffic sensing, AI methods and applications, transportation safety, traffic operations and simulation, and smart urban mobility. He has published approximately 300 peer-reviewed journal articles with over 17,800 citations on Google Scholar. He has delivered more than 210 invited talks and nearly 350 other academic presentations. He received the 2023 ASCE Francis C. Turner award and the Institute of Transportation Engineers (ITE) Innovation in Education Award for 2018. He is a professional engineer registered in Washington and a member of the Washington State Academy of Sciences.

Ph.D., *University of Tokyo, 1998*

M.S. Computer Science/Engineering
University of Washington, 2002

M.S.C.E. Construction Engineering
Tsinghua University, Beijing,China, 1991

B.S. Civil Engineering
Tsinghua University, 1989

Brian Chandler, PE, PTOE, RSP2IB

Transportation Safety Engineer

Brian brings 24 years of experience in transportation safety planning, engineering, and data analysis— including leadership roles at the Missouri DOT, FHWA, and the private sector. He is both a certified Professional Traffic Operations Engineer (PTOE) and Road Safety Professional (RSP) Level 2 in both behavioral and infrastructure disciplines.

Brian has focused on the application of innovative technologies to saving lives, including projects using video-based conflict analysis, automated traffic signal performance measures, and automated/connected vehicle outputs. He recently led the City of Bellevue's School Zone Road Safety Assessment project and the City's Pedestrian Signal Operations Guidelines study. He serves as co-Principal Investigator for NCHRP 17-100: Leveraging Artificial Intelligence and Big Data to Enhance Safety Analysis.

Brian currently leads a team of engineers, planners, and other professionals to save lives. He led the Oregon Strategic Highway Safety Plan (SHSP) 2021 update, and he currently leads the Washington SHSP update planned for 2024. His 2016 textbook Roadway Safety: Identifying Needs and Implementing Countermeasures has been used as the primary text for several university courses on traffic safety.

Previously roles included State Traffic Safety Engineer at the Missouri DOT and Safety and ITS Engineer for FHWA. In both government agency roles he influenced state and federal policy in support of innovative solutions to save lives.

B.S. Civil Engineering
University of Missouri-Columbia, 1998

Darcy Akers, PE

Technical Evaluation Lead

Darcy is a Senior Transportation Engineer in the Smart Mobility group at the City of Bellevue. She has over 10 years of experience in Smart Mobility and signal operations with the City of Bellevue. Recently, Darcy has led the integration, testing and evaluation of video-analytics, LiDAR and edge-computing based systems in Downtown Bellevue to support Passive Pedestrian Detection safety use cases. This effort directly aligns with the project proposed in the RTSSI project. Darcy has been part of the city's Vision Zero team and played an integral role in the implementation of past video analytics pilots.

Darcy is an expert in the traffic signal control system called SCATS and helped with the deployment of SCATS at over 200 intersections in Bellevue. She brings technical expertise in programming adaptive signal controllers and the finetuning of signal operations and timing. She has also managed the city's traffic data program and led an update of the city's guidelines related to the operation and timing of pedestrian signals.

Darcy is a current board member of the ITE Washington State Section and was recognized as the Outstanding Young Professional of the year in 2018 by the Section.

B.S. Civil Engineering
University of Washington, 2015

Appendix II:
Summary Budget Narrative

SUMMARY BUDGET NARRATIVE

The budget of the City of Bellevue's RTSSI project is valued at $1.43 million. A proportion of the awarded funds will be dedicated to city staff to deliver and support Stage 1 efforts of this grant application. Other proportions of the funds will be allocated to the University of Washington, contracted consultants and equipment providers to deliver and support the implementation of the technologies proposed.

Below is a summary of the funding, consistent with the SF424A format:

Funding Category	Amount
Personnel	$250,043.11
Fringe Benefits	$76,158.44
Travel	$14,626.40
Equipment	$392,500.00
Supplies	$1,000.00
Contractual	$579,399.98
Construction	$0
Other	$0
Total Direct	*$1,313,727.93*
Indirect	*$112,803.25*
Total	**$1,426,531.18**

Personnel (request $250,043.11)

This project will be managed and led by City of Bellevue project managers, Daniel Lai, PE (Project Manager) and Franz Loewenherz (Deputy Project Manager). Daniel and Franz have co-led multiple efforts in advancing technology partnerships for the city and are considered subject matter experts in the practice of applying Intersection Safety Systems. Below is a description of their involvement on RTSSI.

Daniel Lai, PE: Daniel will manage the overall project and coordinate with project staff, partners, stakeholders, and the USDOT through all phases of the project. He will be responsible for all planning, deployment, testing, evaluation, and reporting efforts associated with Stage 1. Daniel will coordinate with USDOT staff to report on progress and completion of key milestones on the project, including a visit to Washington, DC. Daniel's involvement on the project will be equivalent to 0.35 FTE, or 14 hours a week.

Franz Loewenherz: Franz will serve as the Deputy Project Manager and will be a secondary point of contact on the RTSSI project. Franz has partnered with Daniel to successfully accomplish many Intersection Safety Systems projects. Franz is a recognized high contributing professional in the field of safety and has built strong rapport with USDOT staff. Franz will be actively involved in communication efforts throughout the project. Franz's involvement on the project will be equivalent to 0.25 FTE, or 10 hours a week.

Additionally, two ITS engineers (0.35 FTE) that are specialized in traffic signal operations will be dedicated to the project to provide technical support efforts and interface with the city's traffic signal control system. The two ITS engineers will also coordinate ongoing project efforts with the selected technical consultant. Two signal technicians (15 hours/week) are also budgeted to support field installation of equipment during the installation phase of the project. The City of Bellevue's team includes other full-time support staff from the city Communications office, grants management staff, administrative staff, and city leadership. All salaries are in accordance with approved salary rates. Staff time for data and performance reporting activities are accounted for in this Section.

Fringe Benefits (request $76,158.44)

The fringe benefits at the City of Bellevue include FICA, Medicare, Municipal Employees' Benefit Trust (MEBT), retirement workers' compensation, unemployment, and vacation and are calculated at 17-20% of salary for full-time employees based on position. Group medical insurance is calculated as approximately $1,400-$1,500 per month for full-time employees.

Travel (request $14,626.40)

The travel costs include transportation, meals, and lodging for four (4) key personnel to attend two (2) in-person project meetings in Washington, DC with USDOT. Travel costs are based on the GSA per diem rates. All travel within Bellevue in support of the RTSSI project is considered incidental to the cost of the project and is not part of the grant request.

Equipment (request $392,500.00)

The RTSSI project will acquire hardware devices that will support the interface between the intelligent field sensors and the real-time traffic signal control capabilities. The combination of hardware includes the following: 1) LiDAR-based sensors, 2) traffic signal control integrator units, 3) edge-computers, 4) wiring, and 5) mounting brackets. The RTSSI project is also dependent on the use of the city's existing traffic camera system which are existing assets in the city and are not part of the grant request to the USDOT.

Equipment procurement will also include all upfront costs required to develop, train, and optimize the software algorithms for the use cases described in Section 1.2 of the grant. Additionally, the development costs will also include development of a web-based user interface that allows the Infrastructure Owner Operator (IOO) to change settings and configurations related to the operations and sensitivity of each use case. The City of Bellevue project team anticipates describing the system functional requirements in the competitive procurement process for vendor adherence. Once the use case capabilities are developed and prototyped in Stage 1, we anticipate that the proposed technology would be able to scale up economically.

The City of Bellevue will adhere to the procurement requirements as described in 2 CFR § 200.33. The City of Bellevue's threshold for equipment purchases is $5,000, which is equivalent to the value described in the NOFO. The per-unit equipment value itemized above is anticipated to exceed the $5,000 discretionary threshold for city purchases and will follow federal procurement requirements.

Supplies (request $1,000.00)

The RTSSI project will purchase minor supplies that will be necessary to install the equipment proposed above. We anticipate that the aggregate total of these supplies will be less than $5,000, as shown on the budget table above. These supplies would include ancillary items such as wiring, connection harnesses, and mounting brackets.

Contractual (request $579,399.98)

If awarded a SMART Stage 1 grant, the City of Bellevue will contract with the University of Washington (UW), a sub-recipient, and a consulting firm to support the advancement of the RTSSI project. The grant request includes 15-months support from a UW Resident Advisor who will support the evaluation of the RTSSI use cases. Additionally, the grant request also includes 15-month part-time support from a consultant to provide technical assistance and support to document the project activities. The consultant will serve as an extension of staff resources to support ongoing delivery of the Stage 1 project.

Key partnership Memorandums of Understanding (MOUs) will also be established with other Non-Government Organizations (NGOs) that have a supporting role on the RTSSI project. The following partners do not require grant funding. However, the City of Bellevue would like to acknowledge their in-kind contributions.

The Insurance Institute for Highway Safety (IIHS) has committed to providing staff support from a Senior Safety Engineer to evaluate the efficacy of the Dilemma Zone Protection project use case. IIHS's in-kind contribution is valued at $40,000 to the RTSSI project.

AAA Washington has committed to providing staff and technical resources to support the outreach efforts on Bellevue's RTSSI project. AAA Washington will utilize their digital communication channels with their 1.2 million members in Washington to seek feedback on the RTSSI use cases and provide outreach and education for this initiative. AAA Washington's in-kind contribution is valued at $20,000 to the RTSSI project.