

Tacoma Tideflats 5G Network Feasibility Study

Findings & Recommendations



Project Contractor



Functional
Feasibility Partner



Technical
Feasibility Partner



Supporting Partners:



Welcome

Let's imagine it is 2030. Samantha slowly wakes up as she hears her alarm and gets her day started with her personal morning guide, "CoTa," the insightful avatar knowledgeable in all things about the City of Tacoma. Samantha is in an apartment that overlooks Commencement Bay, and she listens to "CoTa" as she gets ready for her day recommend the route to get to work on time, provide intellect on air quality for her to better manage her asthma from a personalized daily environmental report, and summarize her daily work schedule. Fortunately, "CoTa" reminds her she has a key meeting she must take from home before she heads down to the Tacoma Tideflats.

Two years ago, Samantha moved to the City of Tacoma to take an apprenticeship position at Husky Terminal. The Tacoma Tideflats has become well known across the globe as an innovator who transformed to a smart port centered around a vibrant city, the University of Washington – Tacoma, a startup hub and a green industrial mixed-use area.

"Cities are complex systems going through lots of changes,"

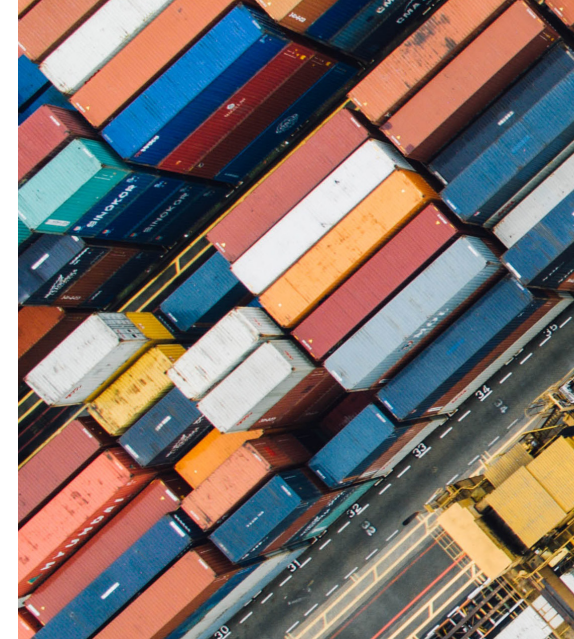
said Joel Baker, Professor and Port of Tacoma Chair in Environmental Science.

"We need to be able to see more a holistic view across various factors (regulations, economics, people, environment, etc.) to understand the complexity and make good decisions."



The Tacoma Tideflats leapt ahead with the foresight and investments it made several years ago to stay ahead of the competition by breaking down the silos between public and private entities. With a focus on working together and sharing data, they created a vibrant ecosystem to benefit them all.

As Washington state and the greater Puget Sound region continue its rapid population growth over the next decade, there are evolving residential and business expectations for a better quality of life. In a recent survey conducted by the City of Tacoma on the future vision for the Tacoma Tideflats, citizens site they love the natural resources and wildlife, opportunities for recreation, AND the Port of Tacoma and the working waterfront. They have interest to support green industrial uses to promote a more environmentally sustainable and equitable economy that leverages the maritime industry and international trade.



The Tacoma Tideflats would benefit from the digitalization of transportation such as real time awareness of the port area, just-in-time arrival of vessels and lower carbon emissions due to shorter waiting times for port calls. As Finland's Minister of Transport and Communications, Timo Harakka, has said, the Finnish Port of Rauma (similar in size to the City of Tacoma), "digital solutions help optimize operations through real-time data sharing between terminals, tugs, pilots, port authorities, mooring personnel, captains and even local shipbuilding companies. Faster and more precise information reduces waiting times, increases port capacity, minimizes unnecessary fuel consumption and improves safety when ships do not have to wait in narrow lanes."

Creating, connecting, and making sense of data across the ecosystem will help to solve challenges the Tacoma Tideflats ecosystem faces today. More importantly it is vital for this ecosystem to be recognized as a technology leader attracting technical leaders from Startups to technology platforms to help prepare the ecosystem for future maritime, green energy, and environmental challenges of tomorrow. Data and the technology that creates, connects, and processes it, are foundational requirements for the digital economy and vital to establishing the Tacoma Tideflats ecosystem to prepare to take advantage of future opportunities and uncertainties.


"What if we had this overhead or 3D view of the entire Tacoma Tideflats that anyone working across the maritime ecosystem could view as a single, common operating view?"

asked Matt Tolentino, CEO Namatad.


"Being able to take real-time data from different operational parts of the area, transform it into actionable information close to the source to minimize bandwidth, leverage that information to make predictions, send those predictions along to some overarching system that manages them and then sends alerts back out to people so they can quickly react is where I see the value in having a rich, highly connected, high speed, low latency network."

Executive Summary


Ports are the lifeblood of many coastal economies around the world, and there is fierce competition to stay ahead. Port operations are highly complex with multiple stakeholders in the value chain. The maritime industry is ripe for opportunity as the Ocean “Blue” Economy is expected to double by 2030 to \$3 trillion. However, tapping into this opportunity requires significant business transformation. The United Nations Conference on Trade and




Ocean economy is expected to double by 2030 to \$3 trillion




97% of Earth's water is in the ocean




98% of Earth is underwater




Infinite clean tidal, wave, and wind energy




8% of people live near the shore



90% of the ocean is unexplored



9 billion people will need protein in 2030



90% of goods are transported by ocean

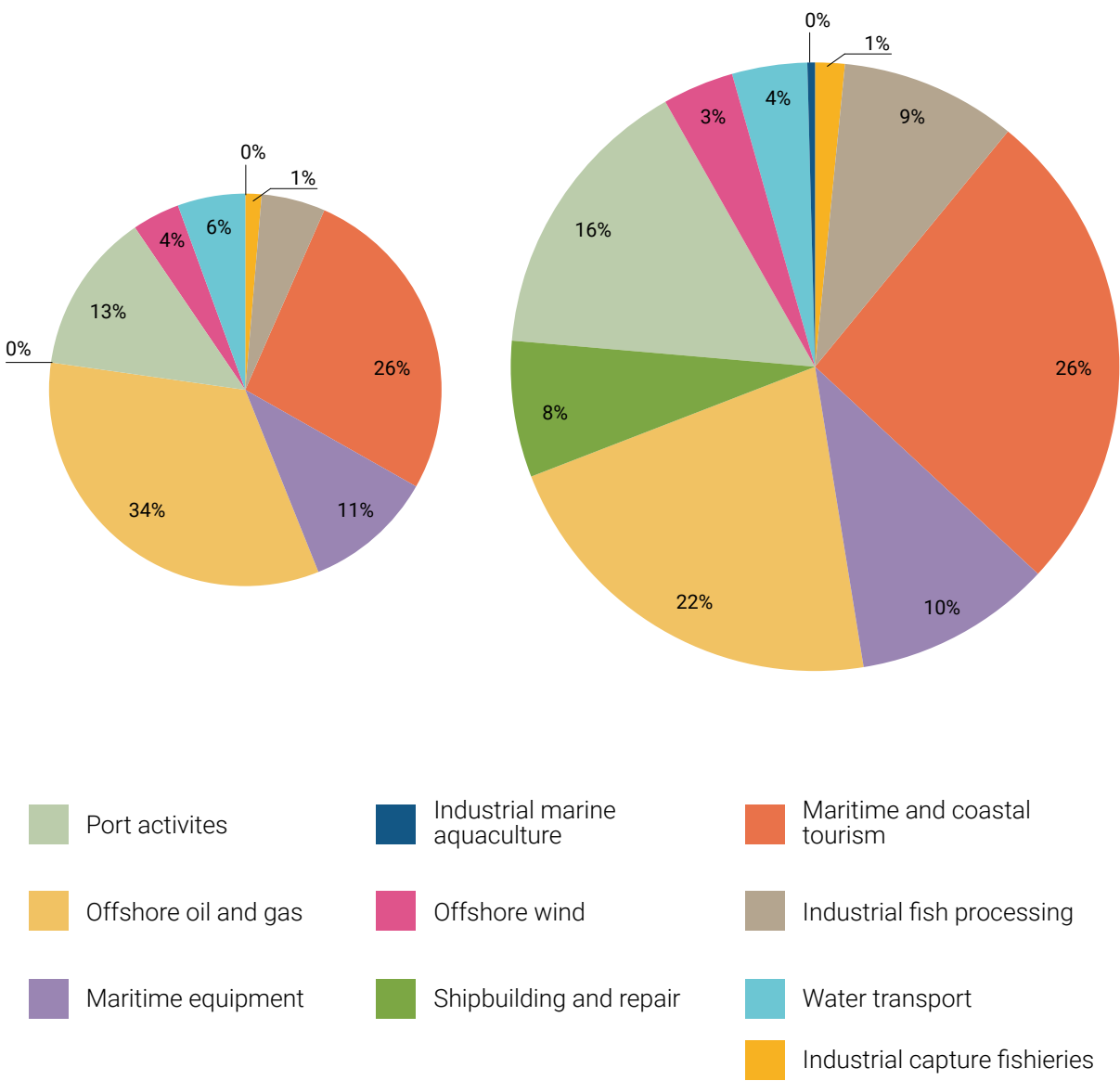
Development (UNCTAD) defines three stages of digitalization in maritime transport:

- **Optimization** – Maximizing efficiency and reliability in existing processes to reduce the cost of trading
- **Extension** – Moving beyond efficiency to produce opportunities for new services and businesses
- **Transformation** – Reinventing logistics, trade and business models, based on data-driven revenues

These stages offer a North Star vision for ports around the world and establish a baseline of success criteria for the maritime industry as it looks to modernize across its holistic value chain.

On a more local level, Washington State has a “Blue Economy” strategy in place to help the state create a thriving and sustainable maritime industry through 2050 and beyond. While the strategy considers the forementioned North Star Vision, this “Blue Economy” offers a local focus and is built upon a platform that fuels economic growth, healthy ecosystems and thriving communities like the Tacoma Tideflats, creating opportunities for all. The Tacoma Tideflats area is uniquely poised to insert itself as an early adopter of this economic benefit and to set itself up as a trailblazer on the path to innovation and sustainability to foster a growing maritime economy.

Value added of ocean-based industries from 2010 to 2030



Washington Maritime Blue – an organization built on broad participation and strong partnerships in the Tacoma Tideflats is working to accelerate bringing this North Star Vision and Washington strategy to life. They have tasked The 5G Open Innovation Lab, Amdocs and Avanade to perform both a Functional User Experience and Technical Network Feasibility Study for the implementation of a 5G network in the Tacoma Tideflats.

Some of the key drivers for the study were:

- Today's fixed connectivity locations constraining port operations
- The need for greater network coverage that is flexible and secure
- Enabling new capabilities and drivers for innovation
- Increasing efficiencies and sustainability
- Increasing workplace safety
- Building an innovation ecosystem to attract entrepreneurship, talent and economic development to Tacoma and Washington State.

The goals of the study were:

- **Understanding challenges:** Work with the Tacoma Tideflats community and its stakeholders to understand the port value chain and its current and future challenges. Determine the probable impacts realized through a high-speed network and edge computing platform.
- **Lead with relevant use cases:** Engage stakeholders on use cases that address current and future challenges and identify pilot considerations as a part of a broader project approach.
- **High-speed network blueprint:** Develop a comprehensive, globally leading, private 5G network project scope addressing requirements, use case prioritization, bill of materials and timelines.



It was also imperative to Washington Maritime Blue to have a high-level of community and stakeholder involvement in the study to validate the core concept, ensure all voices were heard and plan for a future MVP (minimum viable product) phase. Creating business value was paramount to the study.

The following goals ensured value would be realized from the study:

- **Engaging core stakeholders** to understand the needs and priorities of multiple port companies
- **Identifying near-term priorities** to establish use cases to test and prove value before committing to a larger effort
- **Creating a use case roadmap** based on real-world needs across the port partner network
- **Creating a Private 5G strategy** for both current and future state IT investments
- **Exploring potential community impact**

Finally, it was imperative to make an in-person connection with all the various partner and stakeholder groups to ensure we had the true voice of the public, port operators, manufacturers, and technical solution providers to bring together the best of the Tacoma Tideflats to deliver the right outcomes of this study.

The balance of this artifact will further detail the effort, the definition of a high-speed network, study outcomes, use cases, recommendations, and next steps.

Washington Maritime Blue's goals are to maintain and support the growth of maritime, living-wage jobs as technological innovation and digitalization support overall growth and safety. It is necessary to enable the industry to manage the transition to new operating models in a just and fair manner.

“While digitalized and automated processes can deliver benefit to efficiency and safety, their implementation may lead to overall adverse reductions in living-wage, trade-based jobs.

Fair and just management of the social impacts of innovation and transformation required by economic and environmental imperative must be a test of sustainable strategy.

The key to successfully striking this balance is in open, honest dialogue between all parties to find creative and pragmatic solutions that can secure good jobs, economic growth and environmental protection”.

Washington State Strategy for the Blue Economy, (2019) www.maritimeblue.org/strategy

Project Overview

In terms of performing the feasibility study itself, at a high-level, Avanade and Amdocs took a divide-and-conquer approach using parallel paths to focus their areas of expertise and fast-track findings. Avanade was on point for all of the functional experience portions of the study while Amdocs was tasked with tackling the more technical network surveying. Both paths required talking to a variety of stakeholders in the Tacoma Tideflats, each with a different set of questions and focus. Below are some of the highlights of the effort.

Our Approach

Keeping the Tideflats Ahead of the Competition



1:1 Interviews

We met with **19 Individual Stakeholders**



Our Public Workshop

generated over **160 ideas for Leveraging a 5G Network** and our Husky Terminal workshop let us explore a **Key Port Persona**. We validated all of our findings and themes in a **Collective Stakeholder Coalition** in our final workshop and met with Key Technological Partners to gather accelerators and user stories to plan for next steps and intellectual capital for the Tideflats.



Partner Network

We have **Deep Connections** across the globe with ideas and expertise to take the Tideflats to the next level



5G Expertise

We partnered with the **5G Open Innovation Lab** to guide all project efforts and discovery



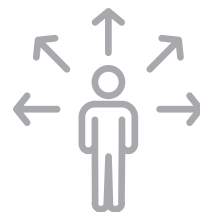
Our Expertise

Focus on Human Factors and Innovation - We are committed to being responsible in everything we do and understand the power of people and technology changing things for the better. We strive to make a positive impact on the world.



Our Assets, Tools & Methods

- Design Thinking
- Leading Communications IP Technology
- Innovative Re-usable Assets
- Technological Accelerators
- Extensive Partner Network
- Change Adoption Strategies



The project vision is set by **Maritime Blue** who is committed to practices that support a **sustainable future** contributing to economic growth, ecological health and **thriving communities**



Network Blueprint

We performed network capacity planning and traffic modeling and created a visual **Topography of the Tideflats** to understand network coverage and dimensioning and then tuned the model based on the 160+ use cases defined to ensure an optimal design and extensive coverage of needs for high-availability and low latency

Supporting Maritime & 5G OIL Partners

The following Tacoma Tideflats stakeholders and 5G Open Innovation Lab partners helped make this study possible.



Joint Innovation Project
Tacoma Tideflats Private 5G Network
Use Case & feasibility study

Core partners



Produced by

Participating Partners



Next Generation Connectivity



One way to reach the 2030 vision that was shared at the beginning of this narrative is the power of next-generation, high-speed networks. 5G is the next ten-year cycle in mobile network evolution and is emerging to address critical wireless communication requirements in public safety, infrastructure and industry. In the last 2-3 years, 90% of the world's data was generated—meaning a massive amount of data is being uploaded onto the Internet every day. As more devices become connected to the Internet, new networking capacities are required that support ultra-low latency and massive network capacity (the amount of data that a network can bare at any given point of time). 5G, and specifically, private enterprise grade 5G networks, will drastically alter how organizations operate and compete, unlocking entirely new use cases and business models across industry verticals.

These networks are designed to connect to massive amounts of new devices generating exponentially large amounts of data that is processed and stored locally through edge computing and/or private cloud environments. Enterprise adoption of private 5G networks is growing and expected to become a mainstream component of enterprise IT investments for years to come.

What differentiates 5G from previous generations of network connectivity?

Faster speed (100x faster)

- Today: 300 Mbps – 1 Gbps
- Tomorrow: 1-10 Gbps; improved wireless coverage and speeds

Reliable and Predictable Performance

- Today: Find the hotspot is a best effort approach
- Tomorrow: Better management of messages to ensure arrival

More Connected Devices (10x more)

- Today: 10k-100k devices per square mile
- Tomorrow: 100k-1M devices per square mile; increased density and proliferation of sensors

Low Latency

- Today: 50-100+ milliseconds
- Tomorrow: <10-50 milliseconds not supported by legacy tech

Private and Secure

- Today: hardware based authentication
- Tomorrow: software and cloud-based: ability to privatize network traffic and secure locally

Network Moves from Hardware to Software

- Today: hardware heavy infrastructure
- Tomorrow: software-based networks

In addition to the public wireless connectivity most individuals are familiar with and use daily, there are also private wireless networks owned and operated by organizations. Organizations are evaluating new wireless networking strategies to support business transformation, particularly related to mobile and connectivity options.

Organizations are interested in private cellular for:

- **Security:** keeping data inside their own network
- **Network cost optimization:** depending on need for high data transfer rates
- **Customized coverage:** control over where coverage needs to be especially across large disperse areas
- **Access to devices and data:** leveraging the massive scalability, and security, of private 5G networks to connect to data generating devices transforming industries digitally
- **New business models:** leverage advances in the technology to re-think overall network strategy (shared model vs. single owned)

There are some differences between public and private wireless. The key ones are:

- Public wireless services the general customer or enterprise while private serves people and things belonging to an enterprise
- Performance is determined by the telco or mobile network operator while in a private wireless environment the local coverage and capacity can be achieved in areas where wireless connectivity is difficult
- Private wireless can have customized services for multi-edge compute and IoT-specific services

Next Generation Connectivity

While there is significant innovation capability in a 5G network, it is still just a network. The applications that run on the new infrastructure are what creates high business value, and organizations around the globe across all industries are beginning to explore what scenarios are needed to support their business transformation.

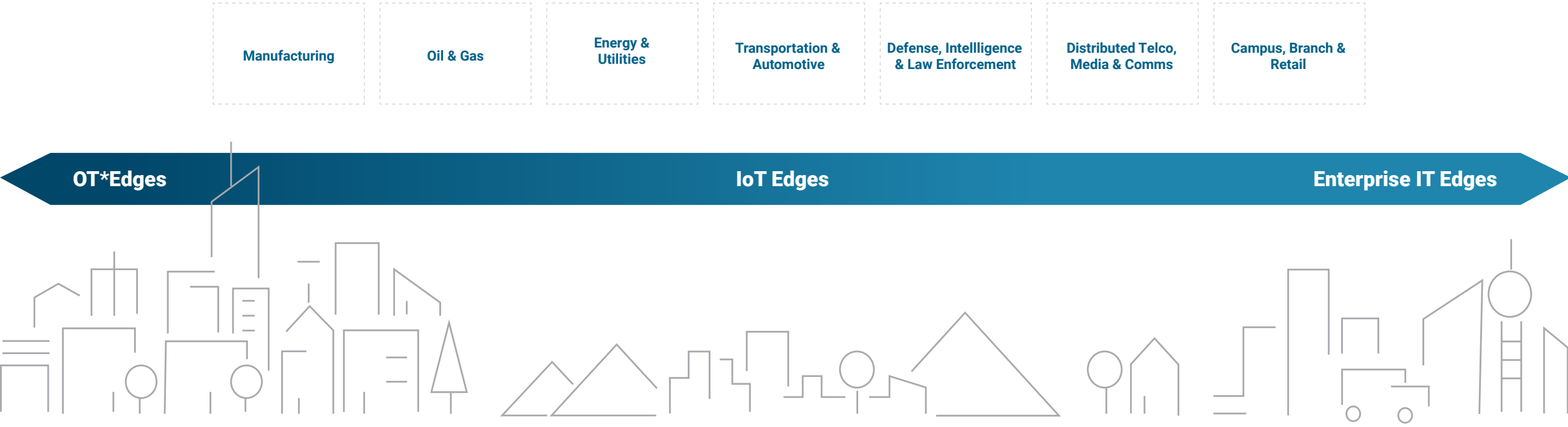
In the data-heavy future, with billions of devices connected to the internet, faster and more reliable data processing will become crucial. Cloud computing, given its centralized nature, has proven cost-effective and flexible over recent years, but the rise of Internet of

Things (IoT) and mobile computing has put a strain on networking bandwidth or how much data can be transferred across a network in a given period of time. Ultimately, not all devices need to utilize cloud computing to operate. In some cases, the back and forth can—and should—be avoided, being close to the data-capture source is a core concept of “edge computing.”

Edge computing and applications will be powered by 5G networks as it enables data to be processed closer to where it’s created (i.e. yard operations, cargo release, vessel arrival, or other sensors), reducing the need to transfer data back and forth to cloud storage and computing. To put it another way, rather

than storing and processing vast amounts of data in large, centralized data centers that may be hundreds or even thousands of miles from a device on the network, edge computing relies on a larger, distributed network of much smaller data nodes to reduce latency (the time it takes information to travel a distance) and increase speed and responsiveness.

As next-generation technology begins to scale, it’s important to take into account both the applications and the infrastructure as together they enable the key use cases that drive business and economic value.



*OT = Operational Technology
**inspired by HPC

Security

As supply chains become more complex and more connected, supply chain security is becoming a bigger and bigger issue for enterprises. As many as four in ten cyberattacks are now thought to originate in the extended supply chain, not the enterprise itself. Modern enterprises have many more points of connection with the outside world than previously. And there's more data flowing through those connections than ever before. That provides essential business agility and speed. But it massively increases the risk profile, both in the size of the potential cybersecurity attack surface, and in the flow of products and components through supply chains.

Edge applications operate on decentralized computing. They are capable of processing data at the edge of infrastructure. This presents new challenges for the detection of bad actors and increases the need for proper security controls.

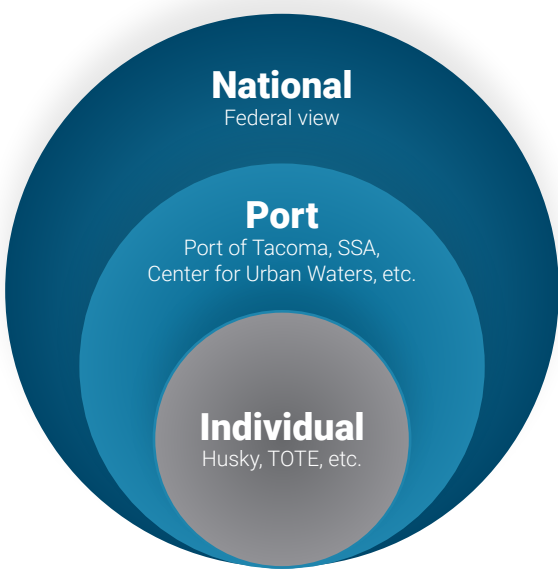
Today's organizations need a new security model that more effectively adapts to the complexity of the modern ultra-connected environments, embraces the hybrid workplace, and protects people, devices, apps, and data wherever they're located. As it comes to private networks, there are many levels of security that need to be considered from cyber to physical and the stakeholders that are involved. Zero-trust is a mind-set.




A change in mindset and approach to securing modern systems

- A technique to address borderless networks, pervasive cloud, integration, hypermobility, and the changing profile of users and partners.
- An approach to security which treats every access attempt as if it's originating from an untrusted network.
- An approach to security which assumes pervasive risk behaviors.

Across all stakeholders, cyber security was a top requirement to implementing a private wireless network, there are new security principles to be considered.

Scott Godwin from Pacific Northwest National Lab, a leading center for technological innovation in sustainable energy and national security, mentioned the importance of understanding the needs and requirements for stakeholders at various levels (see graphic below).



Typical Approach	Modern Approach	New Principles
Users are employees	Employees, partners & customers	
Corporate managed devices	Bring your own devices	 Verify explicitly
On-premises apps	Explosion of cloud apps	 Use least privilege access
Corp network and firewall	Perimeter-less	 Assume breach
Local packet tracking and logs	Explosion of signal	

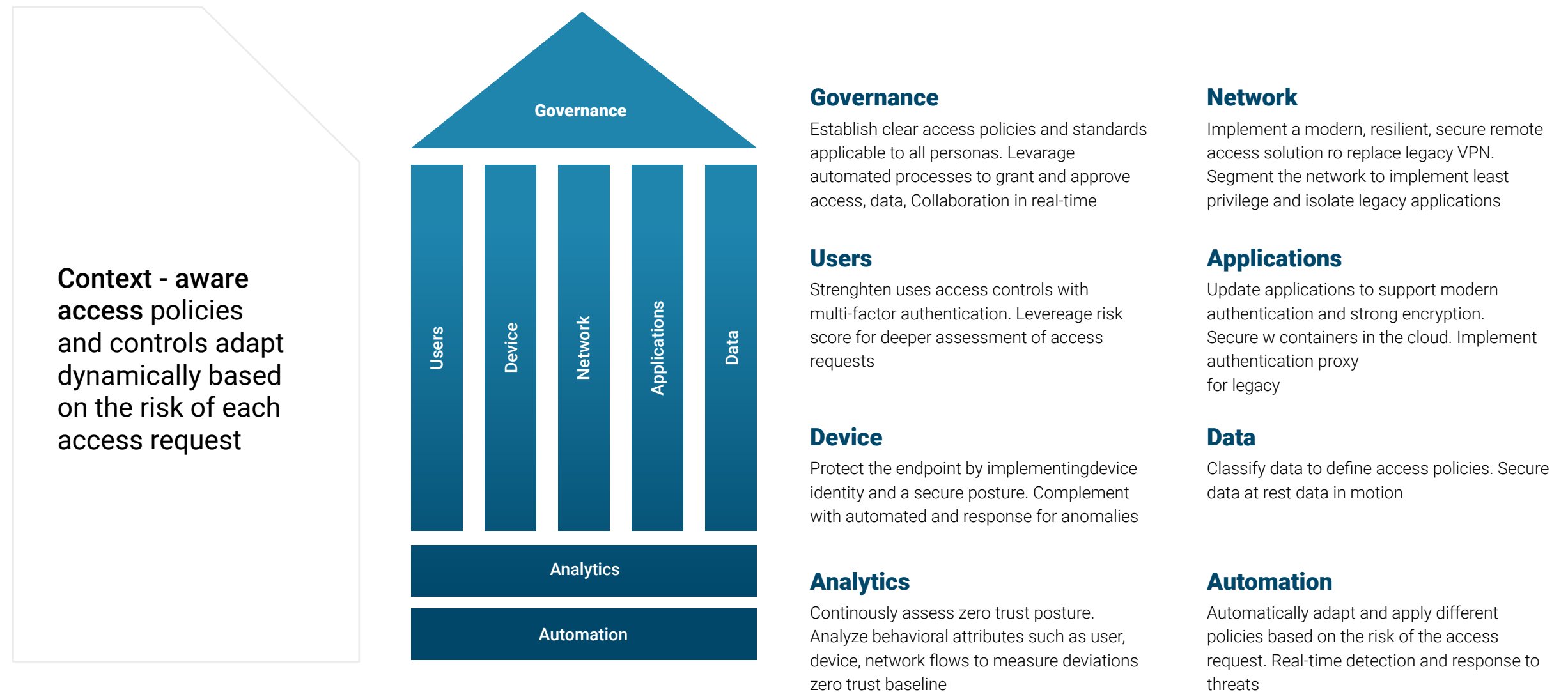
“How we talk about [the] stakeholders and what their interest is in emerging tech, 5G and its application at their level, or how investments are being made at each level in that set of stakeholders is important.

Part of the opportunity here is integrating all interests, efforts and needs to ensure we are not duplicating investment, but we are actually being strategic in how we are tying everything together and bringing others along.”

Scott Godwin
from Pacific Northwest National Lab

Security

For each stakeholder group and scenario, a zero-trust framework needs to be adopted.



As the Tacoma Tideflats begins to enable scenarios leveraging a private 5G wireless network, it will look to leaders like Pacific Northwest National Lab for guiding principles and research on cybersecurity. **The Appendix has a copy of PNNL's whitepaper on Advanced Wireless Communication for Embedded Intelligence for key use cases that mirror this feasibility study findings and provide perspective around cybersecurity.**

Use-Case Summary by Theme

The below graphic is an outcome of the feasibility study and provides an initial point of view on how we can begin to bring the parity of applications on a high-speed, highly secure infrastructure to create business value in the Tacoma Tideflats. This visual reflects the top themes we heard from stakeholders and a summary of the types of use case scenarios that were important to the breadth of users in the Tacoma Tideflats.



Scenarios Identified

Through many interviews and workshops, we started out with a broad base of 8 to 10 themes and 160+ use cases. The process took the stakeholders through divergent and convergent thinking along with prioritization and voting to arrive at a final set of top themes and use cases as highlighted in the graphic above.

The top themes revealed were:

- Orchestration and Efficiency Across the Tacoma Tideflats
- Infrastructure Modernization of the Tacoma Tideflats
- Improving Safety Across the Tacoma Tideflats
- Enabling a Sustainable Future in the Tacoma Tideflats

Each of the themes are comprised of a set of sub-themes that would house a collection of use cases. These were also voted upon by study stakeholders and carried forward throughout the process as the top use cases. Some use cases naturally reside in multiple themes and sub-themes.

Orchestration and Efficiency Across the Tacoma Tideflats

This theme explores working together in new ways (enabled by data and technology) to create efficiency and transparency across the Tacoma Tideflats and beyond. Ideally, this will offer an end-to-end view of the supply chain.

We learned that many of the various entities that do business in the Tacoma Tideflats operate independently, and there are many silos and manual processes that make it a challenge to create a 360 degree view of the port and supply chain. These silos are a major barrier to modernization, and there is a great desire to find ways to come together to understand synergies and create transparency across people, processes, data and technology to make the Tacoma Tideflats a world class place to do business. To get there, our research uncovered the following sub-themes and use cases to drive more efficiency and better orchestration across the Tacoma Tideflats.



Ecosystem Orchestration	Ecosystem Dashboard/ Reporting	Ecosystem Data Exchange
Create a port ‘air traffic control tower’	Mapping & data visualization	Standardized data formats
Open data standards & sharing	Digital Twin of port operations and assets	Understanding and prioritization of sharable v. proprietary data
Real-time 3D interactive model of Port tenants and its operations	Real-time reporting	Data repository and APIs to enable exchange
Real time traffic tracking	Weather forecasting	
Track and trace all assets, vehicles, vessels, trains, equipment and containers	Alerts & Notifications	
Pre-staged trailer gate transactions	Port Dashboard/Intranet	

Infrastructure Modernization of the Tacoma Tideflats

There is both a physical and virtual opportunity to improve the infrastructure in the Tacoma Tideflats. Our respondents felt this would be crucial to staying ahead of the competition and ensuring maritime opportunities are not going to other ports in the US.

Some of the physical considerations

- Land that is being impacted by climate change, and the observation that the land may look different in as few as five years from now based on these changes
- Equipment both small and large that is failing along with the more reactive approach to fixing issues and the high costs associated therein
- Roadways with increasing truck traffic impacting commuters and communities
- Water, its quality, treatment and the sea life it houses
- People and the succession plan for all of their industry knowledge and history

Some of the virtual considerations

- Legacy systems and software running the various operations
- Networks with dead zones and lags due to the unique physical infrastructure
- Silo'd data within each individual organization preventing a 360-degree view
- Manual, paper and people-driven processes that impede efficiency
- Skills that need to be modernized and digitized to support new ways of working and increase throughput to enable more jobs
- Cybersecurity as a top priority across the network, systems and data

The study uncovered the following sub-themes and ideas for how to overcome both the physical and virtual challenges.

Physical Infrastructure	Technical Infrastructure	Virtual Operations
Optimize terminal layout	Cybersecurity as a top priority	Remote operation of equipment
Digital twin for terminal planning, modeling and usage scenarios	Ensure disaster recovery and redundancy	Equip/Vessel predictive maintenance
Flexible Port “Pop Up” space for short/long term container storage	Data protection and large volume processing considerations	Digital container/asset tracking
Refurbish or replace failing physical infrastructure – roads, bridges, rails, land, lg equip, Jones Act, etc.	Need for high availability network & reduced dead zones	Enhanced virtual collaboration tools
Install and maintain sensors across all vehicles, vessels, containers, equipment and assets		Drone-based operations
		Proactive Alerts – Damage, Hazards



Improving Safety Across the Tacoma Tideflats

Every workshop surfaced concerns for worker and community safety and the desire to consider new ways of operating to put safety first.

This topic had the most agreement across the Tacoma Tideflats stakeholders with the desire to come together to create transparency and visibility in the information around incidents that cause risk and require immediate communication, action, ongoing monitoring and heightened awareness. Some of the incidents raised were around hazardous spills, port physical security and access (badging), wildlife considerations, weather incidents, workers safely operating equipment or monitoring facilities or vessels, toxic material handling, etc.

The following sub-themes and ideas offer potential pilot opportunities to improve the next hazardous situation.



Incidents & Alerts	Access & Authorization	Incident Monitoring
Real time alerts on safety hazards and risks	Remote operation of applicable port equipment to enhance safety of workers	Spill, leak and hazardous incident tracking
Real time prediction of roadway incidents	Centralized port security/badging	Proactive weather event warnings/communications
Isolation of hazardous instances	Digitizing port equipment monitoring & maintenance	Environmental monitoring of toxic exposures, hazardous materials, etc.
Proactive data/system monitoring to protect against breaches	Digital geo-fencing of service area for awareness of people, property, equipment in hazardous situations	People-tracking in hazardous areas (geo-location and vitals monitoring to ensure safety)
	Virtual tours – Perimeter walks, vessel visits, trainings, damage, etc.	
	US government & Department of Defense security protocols	

Enabling a Sustainable Future in the Tacoma Tideflats

As outlined in the Washington Strategy for a Blue Economy, increasing ocean-based activities that come with the growth of the maritime industry brings challenges to already-stressed marine ecosystems and communities around them. Threats to the environment involve overexploitation, pollution, decreasing biodiversity, climate change and more. In conducting this study, stakeholders were very clear that they wanted to put ecological and community health at the forefront of Tacoma Tideflats operations, technologies and processes.

To ensure sustainable ocean industries, opportunities need to be carefully managed so the Blue Economy lasts well into the future. Sustainability goals must work hand-in-hand with other legs of the strategy stool to build economic growth and thriving communities.

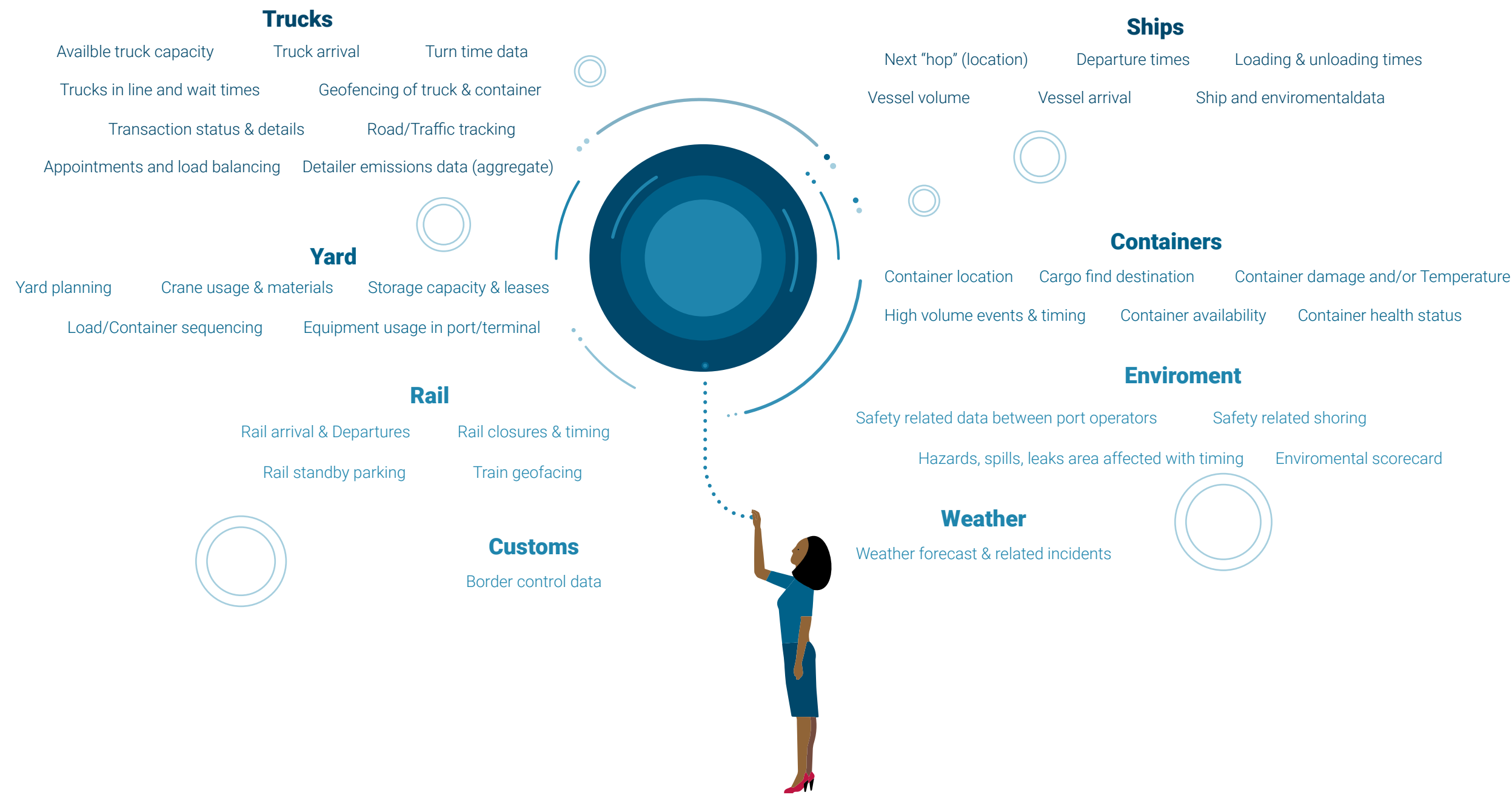
According to The World Bank, “The Blue Economy is sustainable use of ocean resources for economic growth, improved livelihood and jobs and ocean ecosystem health.” Some suggested sub-themes and use cases below offer ways to create this sustainable future.

Renewable Energy Sources	Community & People Impact	Logistics & Operations
Electric charging stations with monitoring for predictive insights	Modeling out long-term impacts of environmental changes (Costs, communities, sea life, phasing, etc.)	Optimize transportation & logistic routes, capacity, arrivals, departures
Hydrogen powered equipment	Air quality testing & reporting	Just-in-time vessel arrivals
Converting ships to running on renewable energy sources	Water quality testing & reporting	Less idling of vehicles and vessels
Reuse of waste throughout the port (ie, metal stamping waste, surface water, storm water, etc.)	Wildlife/sealife monitoring (avoid collisions or disruption to habitat)	High cost to achieve environmental goals
Smart buildings sharing energy in a geographic area	Proactive weather event warnings/communication	Complying with environmental regulations
	Understanding traffic patterns	Changing culture & coming together to work in sustainable ways



Opportunity: Ecosystem Data Sharing

Avanade conducted a deep-dive analysis surfacing lack of shared data as to modernizing and realizing more operational efficiency across Tacoma Tideflats stakeholders. The below graphic illustrates ideas shared for unlocking this innovation.



High-Speed Network Vision

Moving from fixed WiFi to a wireless network unlocks significant flexibility and is an enabler for the leading scenarios identified above. The private 5G network would cover primary data connectivity services and a wide range of additional needs across the enablement of IoT, digitalization, and edge computing.

Based on the use cases and geographic spread, it is recommended to use CBRS (Citizens Broadband Radio Service) band spectrum (3.5 GigaHertz) for the network that is linked with a combination of macro/umbrella cells and small cells built through a phased deployment. The study identified multiple phased designs to reach the entire Tacoma Tideflats for network coverage. This provides flexibility for a build as required model based on enterprises within the Tacoma Tideflats regions priorities. Umbrella cells provide general coverage supporting a greater number of devices typically with lower information rate requirements, while small cells provide densification around high bandwidth applications requiring localized capacity.

For speed of deployment and minimal impact to port operations, repurposing the existing Tacoma Tideflat's infrastructure including floodlight and utility poles is recommended with a focused build along country right-of-ways for secure backhaul availability (backhaul provides a high-capacity line linking the remote site to a core network).



Network Implementation Approach

Proof of Concept:

Implement a proof-of-concept zone with an umbrella site and a cluster of small cell sites with available edge compute networking installed for educational and enterprise evaluation use to incubate initial use case value realization with complete build-out of the first design zone as University of Washington - Tacoma Center for Urban Waters and Washington Maritime Blue as reflected in the image to the right. Quicker use-case enablement and growth of shared use-cases across the Tacoma Tideflat's would also be improved with general macro/umbrella cell deployment across all design zones with further small cell densification at enterprise zones with immediate implementation requirements.

The focus on enabling use cases in the Tacoma Tideflats is critical to the long-term uplift and full implementation across the zones. Providing a preliminary network as a use case proving ground accelerates the applied innovation for various enterprises across the Tacoma Tideflats. This early real-world lab type environment potentially drives environmental, sensor, camera, and AR/VR type use case applications. From the Tacoma Tideflats proving ground, wider scale enablement of lower throughput and reliability supported network may be deployed to maximize potential to the area and determine which zones require additional densification. Tacoma Tideflats' enterprises can take up network utilization over time based on use cases meeting each enterprises' specific business requirements.

Further Deployment Strategy:

Multiple factors were considered on implementing the proposed network, including:

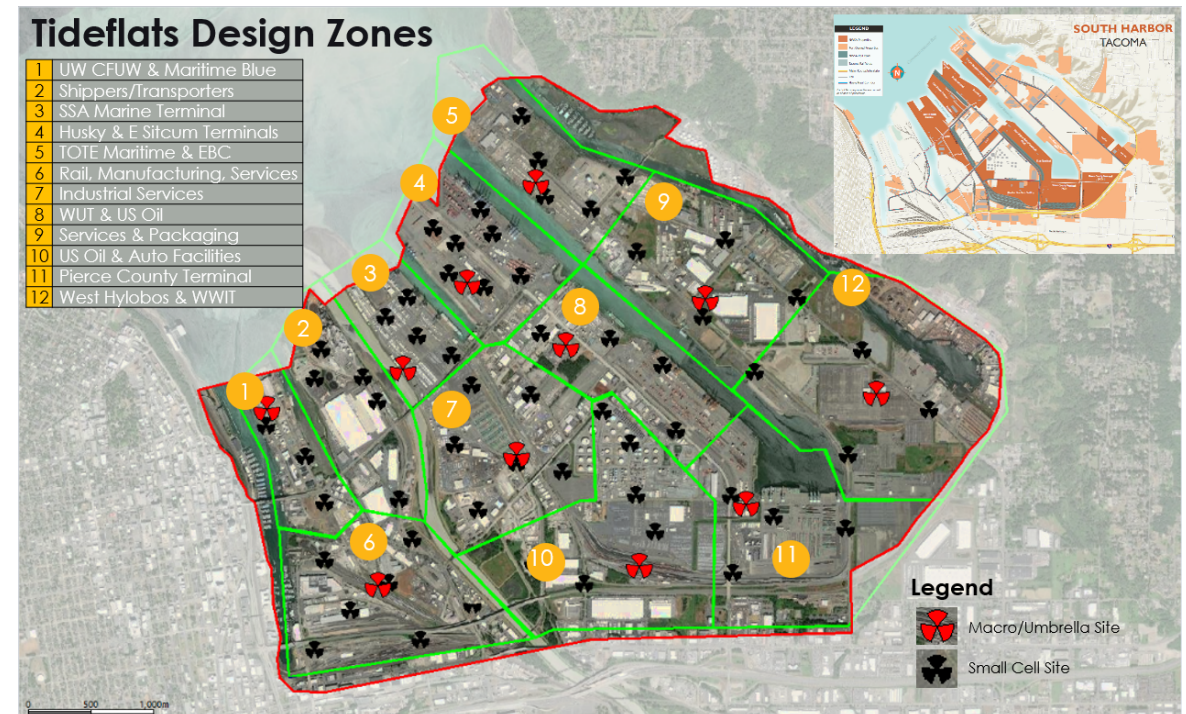
1. Ease of deployment by repurposing existing floodlight poles and utility poles for cell locations
2. Utility poles that fall on or near the Right of Way, for a swifter zoning approval, construction and backhaul connectivity
3. Pursue macro/umbrella and the small cells located near existing fiber infrastructure to meet the ultra-low latency and edge computing use cases.
4. Centralized secure edge compute for POC, general use, and examples for enterprises to utilizes in-house or on secure tideflats edge compute resources.
5. Network slicing implementation to provide tideflat's enterprises secure, high grade of service connections on various use cases versus public shared slices for lower grade of service requirements. **See appendix for more details.**

Recommendations

In our final workshop, we asked the Tacoma Tideflats coalition of stakeholders to help us understand what they view as next steps, obstacles or threats that might stand in the way of moving full steam ahead with the high-speed network and opportunities for leveraging the power of the collective voice of the Tacoma Tideflats to ensure prosperity.

The items below offer a near-term roadmap of what the Tacoma Tideflats consortium feels is needed next:

- Creating a story that defines the business value of a high-speed network to gain adoption



- Sharing various business models for leveraging a high-speed network so businesses know how to buy-in
- Providing more tactical scenarios that model out costs to businesses to plug into the network day 1 and, then, ongoing
- Ensuring backwards compatibility for legacy technology and alternative networks talking to each other to unlock the full power of 5G to businesses both today and tomorrow
- Helping business create a modernization path forward that isn't overwhelming
- Considering a phased rollout approach to balance the risk, cost, reward and affords the runway to bring the entirety of the Tacoma Tideflats along for the journey
- Sharing examples of existing technology solutions that various operators in the Tideflats can utilize once a network is in place

- Continuing to bring the strength of the collective Tacoma Tideflats and their passion for the area together to achieve great results

The stakeholder group felt these efforts could help overcome various bottlenecks and concerns for widespread adoptions of the network. Further planning is necessary to determine who would own and operate the initial and future phases of a network and how to pay for it short-term and long-term. Further discussions with organized labor and the trucking community is necessary to address concerns about automation and equitable access to data while staying ahead of other ports

Establishing a “Proof of Concept (POC) Zone”

Washington Maritime Blue is prepared to further engage with coalition partners to pilot a private 5G network. This allows constituents to see what’s possible by establishing a network proof-of-concept (POC) zone and test a subset of key uses cases that benefit a broader group. This would entail building out a coverage layer over the entire Tacoma Tideflats with densification layers in Zone 1 for the Center for Urban Waters, Zone 4 for Husky Terminal, and potentially another zone to accommodate another operator as an early adopter.

Opportunity 1 – Center for Urban Waters & Open Port Innovation Field Lab

In order to meet the use cases laid out by the City of Tacoma, University of Washington – Tacoma, and Washington Maritime Blue’s Tacoma Maritime Innovation Incubator we would ensure that Zone 1 of the above

network layout has dense coverage including the location of edge computing hardware. Providing access to a private network to innovators and startups seeking to apply IoT technology to Blue Economy sectors will amplify the Tacoma Tideflats area as the prime region in North America for tech development. The Field Lab would also allow Washington Maritime Blue and partners to facilitate and convene specific technology challenges that address key use cases benefiting from shared data and utilization. It would also enable further development of the Northwest Seaport Alliance and Port of Tacoma’s vision for a “Port Community System”.

Opportunity 2 – Husky Terminal

Building out dense coverage over Zone 4 enables early adoption and pilot use cases for Husky Terminal and allows a broader set

of stakeholders to see value in the network for their own operations. It would begin to generate vast data sets that could be used to inform shared data solutions. This also begins to open up markets for current and future solutions providers.

Opportunity 3 – Other interested port operator or manufacturer

If, during early planning, another early adopter is identified and ready to build on a slice of the network, we could provide appropriate coverage based on the details of the proposed use cases.

Joint Innovation Partnerships

Washington Maritime Blue works with its members and partners to accelerate technology innovation through a “Joint Innovation Project” methodology.

As a collaborative approach to demonstration and commercialization we are modeling other global centers of excellence by:

- Utilizing the collective strength of our partners for collective benefit
- Addressing local needs and concerns
- Sharing resources and capacity
- Taking advantage of diverse funding mechanisms

As the project facilitator, Washington Maritime Blue provides program management and oversight including:

- Partnership development
- Collaborative governance models
- Project, finance, and budget management
- Sourcing of funding and investment opportunities
- Flexible finance mechanisms and blending of private and public capital

Establish 5G POC Zone -Umbrella Site + Cluster of Small Cell Sites



App/IoT Implementation Partners & Accelerators

5G OIL Partners & Accelerators

Funding Sources

Establishing a “Proof of Concept (POC) Zone”

Possible Funding Sources

We are at a unique time where there are multiple funding and financing opportunities available for projects that seek to achieve the goals outlined in this report:

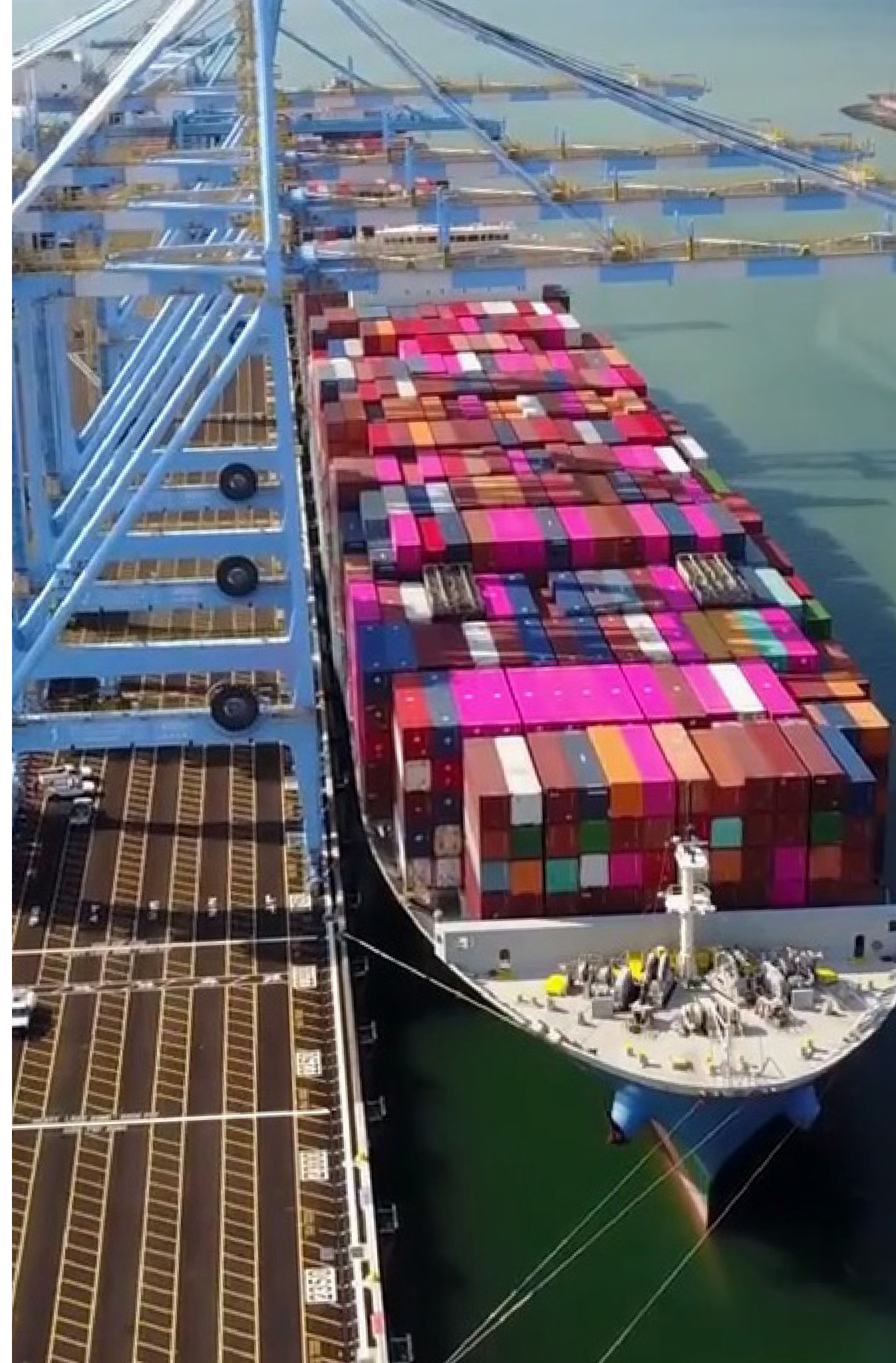
- Strengthening regional economic development and technology innovation
- Building technology infrastructure that supports clean energy, decarbonization, and environmental mitigation and monitoring
- Growth of the Blue Economy including port operations, shipping, logistics and manufacturing

These sources of potential project funding are available from federal, state and local sources as well as private capital. Washington Maritime Blue has recently been awarded Phase 1 planning dollars from the US Economic Development Agency’s Build Back Better Regional Challenge creating eligibility for capital funding towards the construction and operations of the proposed network. Other funding opportunities are also being made available through the latest infrastructure bill passed by congress. This includes the Biden-Harris Action Plan for America’s Ports and Waterways that includes specific funding programs being made available for the modernization of port infrastructure, freight movement, and supply chains.

Federal and public dollars can help buy down the cost of such infrastructure enabling private investment for industry partners and operators. This proposed network acts as public infrastructure that private operators will need to enable the technology platforms and solutions they are planning now, and into the future.

Conclusion

In conclusion, the study shows there is clearly an opportunity for using a private 5G network in the Tacoma Tideflats. The use cases are plentiful! It is now a matter of taking the next steps to further evaluate and explore the deeper requirements, business value and priority of the use cases to take advantage of a high-speed network. Additionally, Washington Maritime Blue will exercise the fine art of testing those use cases that benefit the collective Tacoma Tideflats community while working with all entities interested to explore opportunities to modernize. There is lots of work to still be done to work as a strategic alliance for accelerating maritime innovation and sustainability. Through knowledge sharing, collaborative project development, and enabling an ecosystem for innovation we can collectively realize a shared vision for a sustainable and equitable Tacoma Tideflats and port community.



FACT SHEET: The Biden-Harris Action Plan for America’s Ports and Waterways

While American ports are a cornerstone of the U.S. economy, outdated infrastructure and the COVID-19 pandemic have strained their capacity and jeopardized

<https://www.whitehouse.gov/>



About Washington Maritime Blue

Washington Maritime Blue is a non-profit, strategic alliance formed to accelerate innovation and sustainability in support of an inclusive blue economy. With a mission to implement Washington State's Strategy for the Blue Economy delivered by Governor Jay Inslee's Maritime Innovation Advisory Council, we are a partnership between industry, public sector, research & training institutions, and community organizations. Maritime Blue works to create a world-class, thriving, equitable, and sustainable maritime and ocean industry through knowledge sharing, joint innovation, entrepreneurship, commercialization, business and workforce development.

About 5G Open Innovation Lab

The 5G Open Innovation Lab is a global applied innovation ecosystem for corporations, academia and government institutions working together with early- and later-stage start-ups to fuel the development of new capabilities and market categories that will transform the enterprise. We give startups at all stages unparalleled access to open platforms and markets needed to create, test and deploy new use cases and innovations for 5G and 5G-enabled technologies, including artificial intelligence and edge computing. We deliver actionable knowledge and market insight that helps our partners and member companies deliver value to customers and grow their revenue and leadership positions. Ultimately, the Lab is a global catalyst committed to the transformation of enterprises utilizing intelligent software-defined platforms.

About Avanade

Avanade is the leading provider of innovative digital and cloud services, business solutions and design-led experiences on the Microsoft ecosystem. Our professionals bring bold, fresh thinking combined with technology, business and industry expertise to help make a genuine human impact for our clients, their customers and their employees. We are the power behind the Accenture Microsoft Business Group, helping companies to engage customers, empower employees, optimize operations and transform products, leveraging the Microsoft platform. Avanade has 49,000 professionals in 26 countries, bringing clients our best thinking through a collaborative culture that honors diversity and reflects the communities in which we operate. Majority owned by Accenture, Avanade was founded in 2000 by Accenture LLP and Microsoft Corporation.

About TTS-Wireless

TTS-Wireless, an Amdocs Company, provides network engineering services for over 20 years to leading global telecommunication mobile network operators and ecosystem providers. As Amdocs, with our market-leading portfolio of software products and services, we unlock our customers' innovative potential, empowering them to provide next-generation communication and media experiences for both the individual end user and enterprise customers. Our 28,000 employees around the globe are here to accelerate service providers' migration to the cloud, enable them to differentiate in the 5G era, and digitalize and automate their operations. Listed on the NASDAQ Global Select Market, Amdocs had revenue of \$4.3 billion in fiscal 2021. For more information, visit Amdocs at www.amdocs.com.

Appendix

Design Thinking Approach

Avanade leverages a human-centered approach to problem-solving called Design Thinking that focuses on people above all other factors in understanding and studying a situation, problem, process or product. Design Thinking transforms the way we approach problem solving. Reducing risk and increasing stakeholder engagement through research-based decision making, collaborative brainstorming, and iterative prototyping. There are 5 guiding principles of design thinking that make it highly effective in understanding user experience and in deriving a high volume of ideas and use cases in innovation scenarios.

They are as follows:

- **Human Centered**

We ground everything we do in human needs and feedback through engaging and empathizing with the people who will be impacted by our designs.

- **Collaborative**

We leverage cross-functional teams with different backgrounds and viewpoints to create new and holistic insights and solutions.

- **Creative but Structured**

We have fun and think outside the box, but we go in with a structured process that defines the challenge we're solving for and uses proven tools and activities to create tangible results.

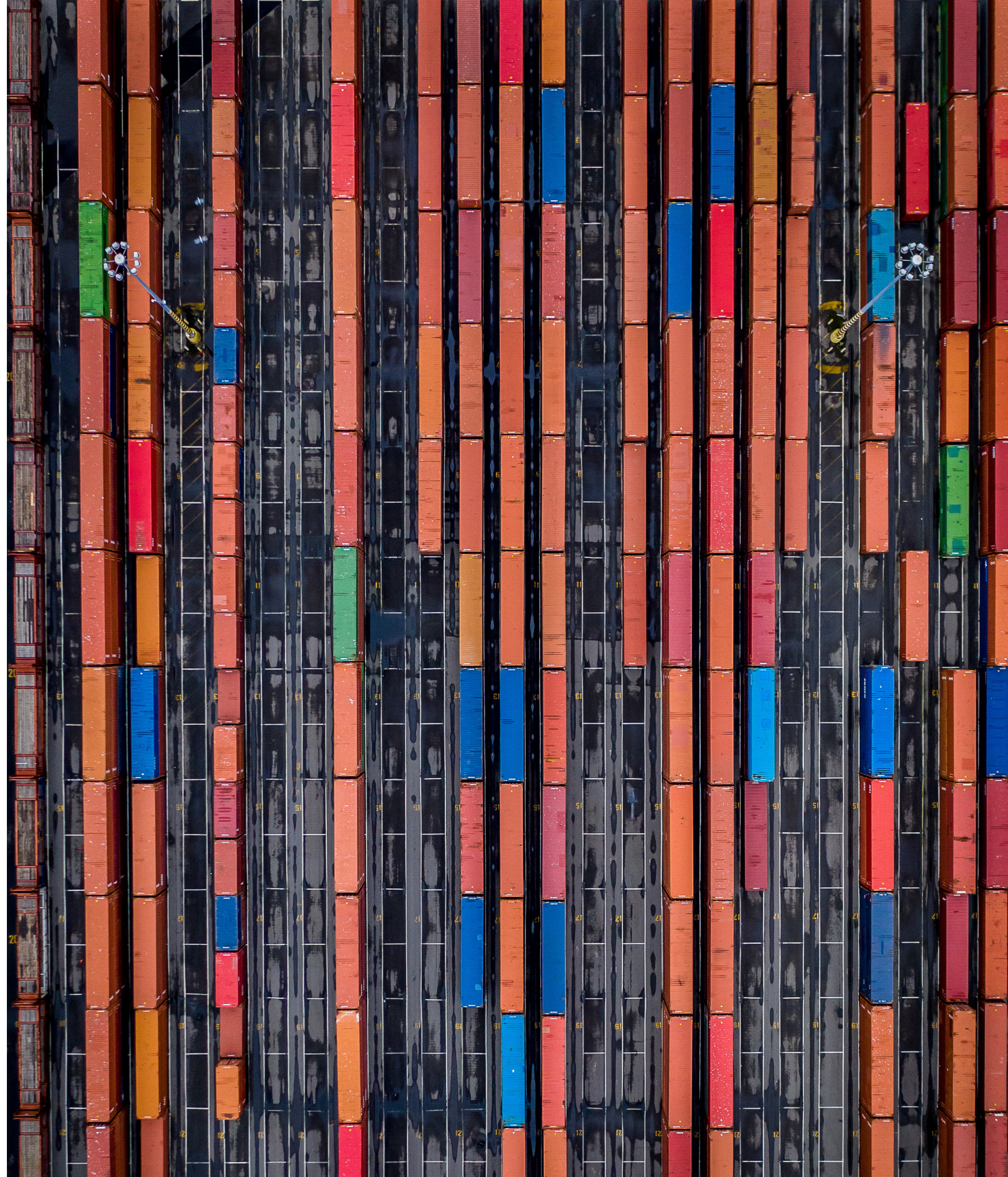
- **Prototype Driven**

We use visual representations of our ideas and solutions that can be tested, create alignment and can be understood by all.

- **Iterative**

We always test our ideas and prototypes with users and stakeholders to validate our understanding then re-design based on feedback to design a better and more grounded solution.

The most effective way to drive focus, value and reduce risk is through a clear, research-driven process of defining the right problem to solve and then solving it in just the right way. Our Design Thinking approach is always intentionally moving through this process.



Project Plan

Avanade performed a combination of ethnographic research and concept ideation to arrive at a set of overarching themes and use cases. The research and ideation was focused on uncovering Tacoma Tideflats Stakeholder digital initiatives and modernization efforts and the prioritization of those efforts as they pertained to a high-speed network.

The below information details how we gathered the information and who in the Tacoma Tideflats we spoke with during the efforts. It was essential to cover a breadth of the Tideflats community to hear the voice of a variety of factions in understanding the feasibility and potential use of a high-speed network.

Ethnographic Research (45 minute sessions):

Conduct 19 one-on-one Interviews with a combination of the following individuals to understand how a high-speed network could enable innovation, lower costs and speed-up operations.:

- Port operators
- Port manufacturers
- Solution providers

The following more granular themes surfaced as a result of the personal conversations with key stakeholders:

- Physical and Virtual Security/Safety
- Transportation Connectedness, Visibility & Transparency (Vessel, Rail, Truck)
- Environment – Net Zero, Reuse, Stormwater, Electric, Sea Life, Air, Traffic
- Track & Trace
- Autonomous Vehicles/Equipment – Lens of safety
- Shared Systems and Data
- Failing Infrastructure – Proactive v. Reactive Approaches
- People Considerations – Skills, Retirements, Modernization
- Improving Efficiency
- Technical Modernization

WS#	Date	Audience	Goal	Outcomes
1	November 5, 2021	Large Public Sector	Gather a broad range of use cases	160 use cases captured
2	November 9, 2021	Single Part Operator-Husky Terminal	Understand use cases as they pertain to the port operator persona	Roadmap of top use cases a port operator and top themes from first 2 workshops and interviews
3	November 16, 2021	Port Operator, Manufacturer, Solution Provider	Use top themes and use cases from the prior 2 workshops and interviews to understand what resonates with the broader Tideflats community of stakeholders to prioritize use cases that would carry forward into next steps, understand any bottlenecks or threats, define next steps	Top 4 Themes and Use Cases to carry forward for the study
4	November 19, 2021	SG Solution Provider Workshop	Share the top themes and use cases from all the workshops and have solution partners match capabilities to the use cases to understand accelerators as we move towards next steps	Identify Use Case accelerators to jumpstart implementation efforts in future phases

Technical Network Feasibility Details

A feasibility study of a 5G network build-out was conducted across the Tacoma Tideflats to scope an initial network design in support of various use cases identified from the interviews and workshops performed by Avanade. The enabling design is capable of a phased network implementation plan to support the priority use cases unlocking additional value to the Tacoma Tideflats area ecosystem.

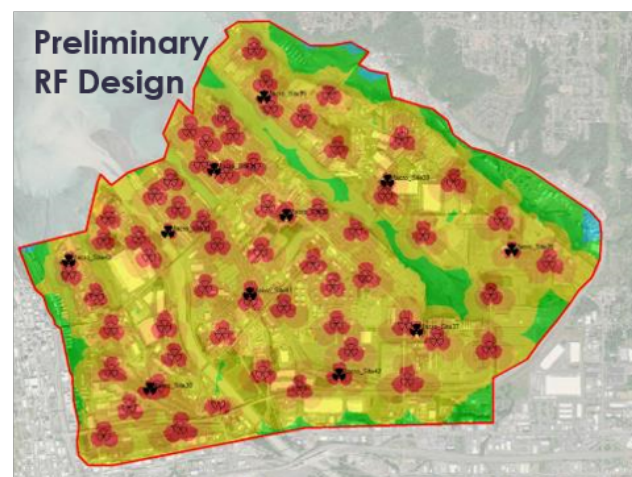
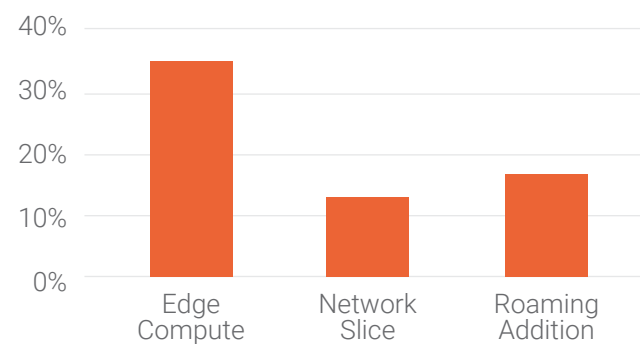
Private 5G Network Feasibility Study Design Criteria:

- Design Strategy: The use case driven 5G network design identifies key network elements required. Spectrum and backhaul dimensioning are essential aspects of the design to support the quantity and information rates required of devices. Targeted designs are utilized to meet use case requirements around locations expected. The proposed network design will be a Multi-Band/HETNET (The concurrent operation of umbrella cells and small cells is termed heterogeneous networks).
- Coverage Dimensioning identifies critical areas requiring optimal radio conditions to operate and perform specific services to the meet the necessary grade of service. Broader coverage requirements fulfill mobility for potential data driven operations, an umbrella cell layer with further small cell densification is recommended for locations driving processes that require high data rates.
- Nominal Coverage Planning, performed in several iterations, from identification of nominal cell locations and optimizing height availability for ideal site selection.
 - Field surveys were performed to gather coordinates of the utility poles on the public right of ways, followed by drone surveys for 3D modeling. Drones capture potential blockage of the radio signal because of existing infrastructure allowing for alternate coverage solution, like a CPE, recommendations for these scenarios.
 - Potential antenna locations are grouped into clusters, becoming the basis of the deployment chronology.

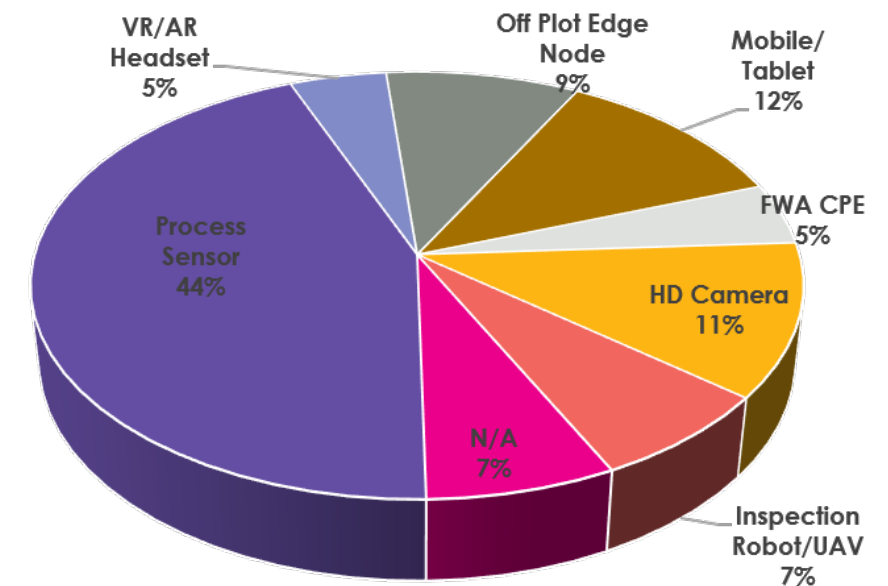
- Capacity Planning expands into the identified use cases by quantifying inputs such as number of devices, bandwidth requirements of each device, expected spectrum utilization, number of users, compute/storage, and backhaul utilization. This includes network, backhaul, edge and cloud compute considerations.
- Security of the network with necessary firewalls, policy, network monitoring, and utilization of secure network slices on 5G to separate various enterprise security requirements from the shared slice across common tideflats use-case traffic.

Network design buildout is often an iterative process refining it throughout the life cycle as usage patterns change and new use cases are put into action. The outcome of the network study provides a phased network buildout approach allowing for bringing use cases quickly to market and scaled expansion.

Key Use Case Enablement



Identified Use Case Types



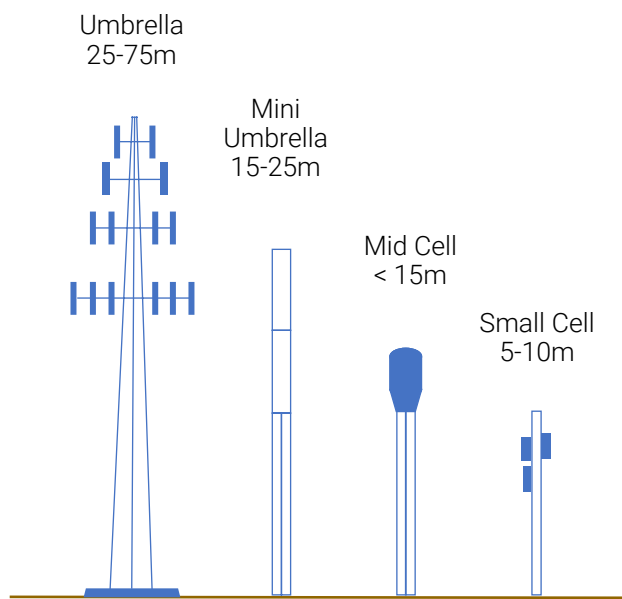
Device Type	Committed Information Rate	UL%	DL%
Off Plot Edge Node	384kbps to 5Mbps	70	30
Process Sensor	50kbps to 5Mbps	90	10
HD Camera	8Mbps	95	5
Inspection Robot/UAV	2Mbps	50	50
Mobile/Tablet	10Mbps	30	70
VR/AR Headset	50 to 100Mbps	50	50
FWA CPE	100Mbps	50	50

Technical Network Feasibility Details

5G allows designing the network based on the exclusivity of targeted use cases and covers the primary voice and data services and a wide range of other services from the enablement of IoT and edge computing.

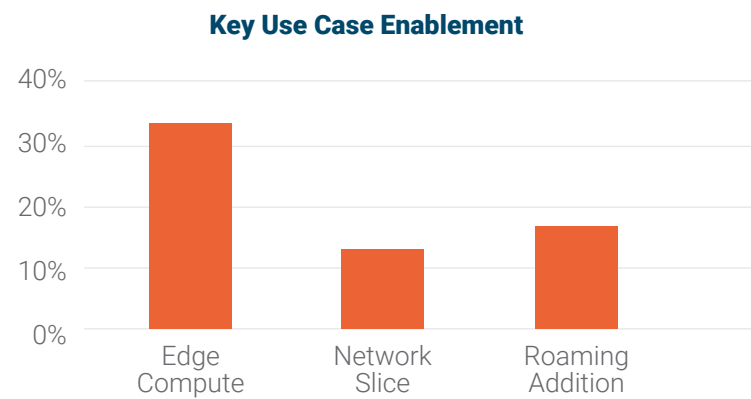
Using the CBRS (Citizens Broadband Radio Service) band (3.5GHz), the proposed network is a combination of umbrella cells and small cells built through a phased deployment. The study identified multiple phased designs to reach the entire Tacoma Tideflats for network coverage. This provides flexibility for a build as required model based on enterprises within the Tacoma Tideflats regions priorities.

Umbrella cells are typically 25-75m in height offer an over-arching coverage for larger scale areas to deliver data services that typically demand lower bandwidth such as IoT sensors and basic messaging. For speed of deployment and minimal impact to port operations, repurposing the existing Tideflat’s infrastructure including floodlight and utility poles is recommended.



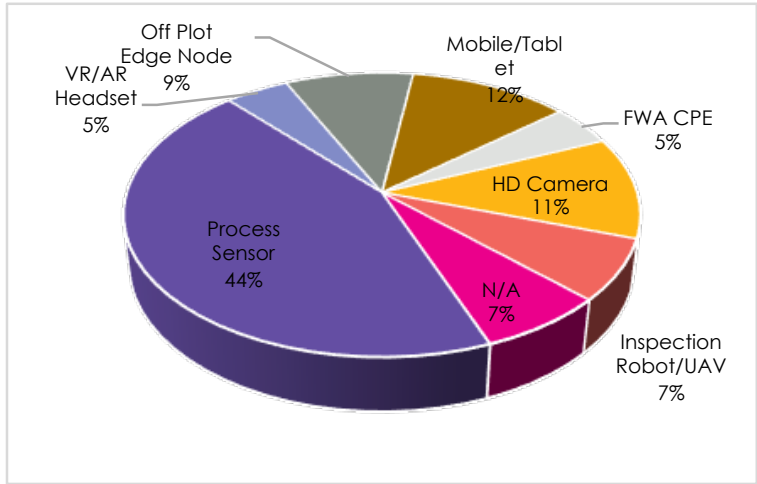
Small cells range from 5-10m, densifying the network if focused use areas, satisfies the high data rate use cases like UHD camera, AR/VR, and broadband services. These cells can be build-to-suit deployments on specific use case needs. Deployed in greater numbers typically than umbrella cells, reusing utilities poles for this ecosystem. The feasibility usability initial use cases gathered from the Tacoma Tideflats’ stakeholders who participated in the discovery sessions with Avanade. The mapped the use cases bring together a varied counts of compute devices, sensors, camera systems, and broadband services expected to fulfill the requirements.

Device Type	Committed Information Rate	UL%	DL%
Off Plot Edge Node	384kbps to 5Mbps	70	30
Process Sensor	50kbps to 5Mbps	90	10
HD Camera	8Mbps	95	5
Inspection Robot/UAV	2Mbps	50	50
Mobile/Tablet	10Mbps	30	70
VR/AR Headset	50 to 100Mbps	50	50
FWA CPE	100Mbps	50	50



Mapping potential 5G offerings to the use cases, the following three scenarios were identified:

- Enhanced Mobile Broadband (eMBB): Enhanced mobile broadband brings exceptionally high throughput speeds tied to adequate spectrum availability. eMBB is the key to improved user experience streaming and relaying high-quality videos scenarios. Enabling various AR and VR capabilities, edge-compute, accessing cloud-based applications while out in the tideflat’s region, monitoring traffic conditions inside the TacomaTideflats across crucial entry/exit areas - effectively modernizing operations to the next-gen technology platforms.
- Massive Machine Type Communications (mMTC): mMTC provides a seamless environment for massive machine communications over wired or wireless networks where machine interactions happen with minimal to no human intervention. Scenarios requiring low data rates and high device density. These low-power, non-guaranteed latency applications preserve batteries on deployed devices that can last up to 15 years.
- Ultra-Reliable & Low Latency Communications (URLLC): Promising almost perfect reliability and network availability is one of the key features of 5G. With ultra-low latencies of 5ms, the feature supports a thick layer of sensors and IoT devices. Critical for automation services where service requires real-time enablement like self-driven vehicles and smart electricity grids, this aspect of 5G caters to such requirements.



Network Implementation Approach

Proof of Concept: A proof-of-concept zone is recommended by enabling an Umbrella site and a cluster of small cell sites for educational use.

Urban Waters – Zone 1



initial use case value realization with complete build-out of design zone 1. Quicker use-case enablement and growth of shared use-cases across Tideflat's would also be improved with general macro/umbrella cell deployment across all design zones with further small cell densification at enterprise zones with immediate implementation requirements. The focus on enabling use cases in the Tideflats is critical to the long-term uplift and implementation across the zones. Providing a preliminary network as a use case proving ground accelerates the applied innovation for various enterprises across the Tideflats. This early real-world lab type environment potentially drives environmental, sensor, camera, and AR/VR type use case applications. From the Tideflats proving ground, wider scale enablement of lower throughput and reliability supported network may be deployed to maximize potential to the area and determine which zones require additional densification. Tacoma The Tideflats' enterprises can uptake up network utilization over time based on use

Tide Flats – Zone Map



cases meeting each enterprises' specific business requirements.

Further Deployment Strategy:

Multiple factors were considered on implementing the proposed network, including:

1. Ease of deployment by repurposing existing floodlight poles and utility poles for cell locations
2. Utility poles that fall on or near the Right of Way, for a swifter zoning approval, construction and backhaul connectivity.
3. Pursue macro/umbrella and the small cells located near existing fiber infrastructure to meet the ultra-low latency and edge computing use cases.
4. Centralized secure edge compute for POC, general use, and examples for enterprises to utilize in-house or on secure tideflats edge compute resources.
5. Network slicing implementation to provide tideflat's enterprises secure, high grade of service connections on various use cases versus public shared slices for lower grade of service requirements.

Right of Ways



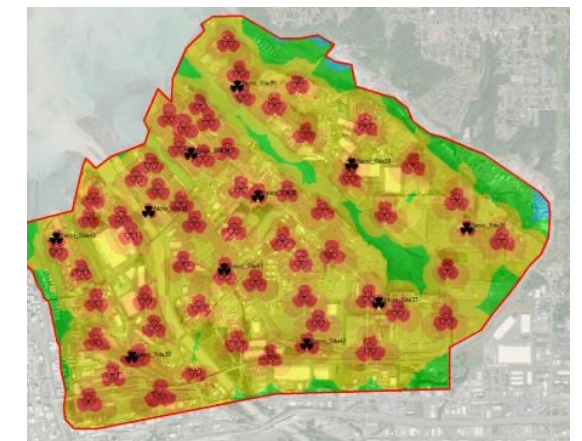
Coverage Layer:

The macro/umbrella cells that provide a coverage layer to the broader tideflats area allowing use cases that can be exhausted using the available capacity and regions that do not require densification or dedicated network resources.

Densification Layer:

Phase 2 densifies the network by adding small cells to the grid in the phases described in Tide Flats – Zone Map below. These small cells are intended to support the high bandwidth and Information rate requirements from various use cases like Ultra HD video recording and streaming. Arraying through the zones, the port stakeholders can prioritize the deployment based on the use case, zone ownership, and ease of activation. Since the various intelligent sensors, devices, camera systems, CPEs, VR/AR devices were assumed to be generic, the specificity of each of these devices needs to be evaluated in parallel to the network design. These studies

Coverage Map



will help keep the assumptions in check and not overload the network once these devices are fully loaded.

Operational Readiness:

Implementation of a centralized administration for network administration (onboarding, policy control, support, vendor management), network monitoring (capacity, fault management, performance), edge utilization (implementation, validation, and capacity growth), and security across all aspects (access, systems, administration) to allow on-going operations and ease of adoption is recommended for scaling the network expansion.

Security Whitepaper – Pacific Northwest National Laboratory



Pacific Northwest National Laboratory (PNNL) is merging its rich history in advanced wireless communications with our expertise in cybersecurity, artificial intelligence (AI), sensors systems, and Internet of Things (IoT) connectivity. Our forward-leaning focus on the nexus of these technologies allows PNNL to address the challenges presented by a hyper-connected, physical-digital, 5G world reliant on edge computing to create autonomy at a whole new level, changing the future threat landscape.

Over the past decade, PNNL's research and development in advanced wireless communication has garnered attention from many partners who acknowledge PNNL's leadership. This work has featured monitoring of wide spectrum communications, wireless cybersecurity, millimeter wave technology, embedded sensor systems, and IoT connectivity.

Areas of research

PNNL is focusing on three main areas of 5G research to support key mission needs based on PNNL's areas of expertise. The critical areas of research include:

1. Adopting 5G communications and computing architectures into sponsor mission spaces, advancing sponsor capabilities;
2. Exploring security implications of applying emerging 5G solutions for critical or vulnerable systems, and exploring supply chain; and
3. Developing novel compute paradigms, bringing PNNL's capabilities and strengths alongside industry early in development.

These combined areas assure our nation can keep pace in the global race for 5G and advanced wireless communications.



Security Whitepaper – Pacific Northwest National Laboratory

Impacts of research

Advanced Automation

- **Challenge:** Edge applications operating on decentralized computing are capable of processing data at the edge of the infrastructure. This presents new challenges for the detection of bad actors and increases the need for proper security controls to understand and mitigate the current threat and attack landscape at the edge.
- **Research Emphasis:** Edge computing enabled by deploying 5G and AI at the edge holds tremendous promise to transform every portion of civilization. At PNNL, we believe it is imperative to understand how new paradigms will allow devices in the field to compute and respond in real time. In addition, it is important to reduce their size, cost, and complexity while distributing authority and enabling a new level of regional coordination and optimization.

Distributed Remote Awareness

- **Challenge:** Assuring a secure, end-to-end connectivity that spans rural to urban environments is required to create a distributed remote awareness, enhancing the connection between individuals and machines to perform complex operations over geographically large regions.
- **Research Emphasis:** At PNNL, we look to 5G to create a distributed remote awareness that can provide first responders and others in the field with a common operating picture and wholistic understanding of how their actions coordinate with the larger picture. It also creates the possibility of remote operations and targeted remote assistance, as well as timely situational awareness for decision makers from response through recovery.

System Security and Assurance

- **Challenge:** As a national rollout of 5G and associated applications become available and connected to global networks, it is essential to understand the implications and security of hyper-connectivity of devices. It is important to recognize that many of these devices will be autonomous in nature, with little to no human input or direction.
- **Research Emphasis:** PNNL's work in advanced wireless communication is linked to our work securing operational technology. This includes ensuring security across the virtual and physical worlds to assure the protection and resilience of critical infrastructure, the emergence of AI, autonomous systems, and related IoT applications.

PNNL core capabilities

- 5G
- Artificial Intelligence
- Augmented / Virtual Reality
- Autonomous Vehicles
- Edge and Cloud Computing
- Cybersecurity
- Embedded Sensor Systems
- Internet of Things
- Radio Frequency
- Streaming Video Analytics
- Millimeter Wave Technologies
- Software Defined Networks
- Software Defined Radios

Security Whitepaper – Pacific Northwest National Laboratory

Supply Chain

- **Challenge:**

The adoption of automation utilizing advanced wireless communications will transform corporations, governments, agriculture, and cities. Operations will be forced to adopt new technologies to remain competitive. Our country will rely on these newly connected critical national functions, making it imperative to protect them from undue influence.

- **Research Emphasis:**

PNNL is supporting efforts to assure our nation has a domestic supply of trusted, certified and/ or authenticated materials, hardware, firmware, and software for our wireless communications.

Working with PNNL

Sponsors come to PNNL because of our flexibility and ability to pull in the right set of experts for the project. At PNNL, project teams and testing environments are flexible. We frequently bring together expertise from a broad set of fields to solve current and emerging challenges.

Testing can occur in a variety of environments, including walkin anechoic chambers, faraday cages, and offsite testing environments, from rural to urban settings, to closely match the environments of expected mission need. Given the critical use-cases imagined for 5G, flexibility in project staffing and test locations will continue to be incredibly important for research and development and cross-domain solutions will increasingly be in demand to assure performance.

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U.S. DEPARTMENT OF
ENERGY

PNNL-SA-155162 | AUGUST 2020

5G Open Innovation Lab Partner Solutions

The partners of the 5G Open Innovation Lab have shared the following examples of where they have done work on similar use cases.

<div></div> <div>Ask us about partners of the 5G Open Innovation Lab like these who offer solutions across the themes to accelerate your implementation efforts.</div>	<div></div> <div>Cybersecurity solutions, user secure access and application security</div>	<div></div> <div>Mission critical cellular networks in public and private operators including worker and environmental safety.</div>	<div></div> <div>Digital twin to simulate the full network and emulate any number of existing and new users, applications and traffic on the network.</div>	<div></div> <div>Worked with enterprises to enable predictive maintenance in factories and remote operation of dangerous tasks.</div>
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