PNNL-SA-157568



Implementing a Vision to Create and Deploy the Airport Risk Assessment Model (ARAM)

PNNL's Community Science & Technology Seminar Series

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10 November 2020



AIRPORT RISK ASSESSMENT MODEL

# Agenda • What is ARAM? • Risk basics and ARAM methods • Then and now • "Demo" • Questions

# Airport Risk Assessment Model

 Developed by Pacific Northwest National Laboratory – first model to dynamically quantify risk from terrorist threats at airports

 Automatically optimizes recommended assignment locations of deployable security countermeasures

 Demonstrated to DHS S&T, TSA, Port of Seattle Security/Police Department, and Delta Airline Security

 Operationally deployed at Sea-Tac starting in September 2019; additional airports to follow

O Sponsored by DHS S&T – APEX Program





- *Risk*: Potential for an unwanted outcome resulting from an incident, event, or occurrence, as determined by its likelihood and the associated consequences
- *Risk Score*: Numerical result of a semi-quantitative risk assessment methodology
  - Gauges the combination of *threat*, *vulnerability*, and *consequence* at a specific moment and location
- Basic risk equation:





Risk Steering Committee

DHS Risk Lexicon

September 2010



### **ARAM** AIRPORT RISK ASSESSMENT MODEL



# ARAM Risk Engine Math Program Formulation:

- <u>Objective function</u>: Minimize Daily Risk
- <u>Decision variables</u>: where and when to place assets
- <u>Constraints</u>: asset availability and other imposed requirements

Min:  

$$\sum_{t,k,l} \hat{R}_{kl}^{t} \exp\left[\eta_{2k} \sum_{ij} X_{ijk}^{t} \ln E_{li} + \sum_{ij} X_{ijk}^{t} \ln D_{li}\right]$$
subject to:  

$$\sum_{k} X_{ijk}^{t} \le a_{ij}^{t} \qquad \forall i, j \in J(i), t$$

$$X_{ijk}^{t} \le a_{ij}^{t} \alpha_{ik} \qquad \forall i, j \in J(i), k, t$$

$$X_{ijk}^{t} \in \{0,1\} \qquad \forall i, j \in J(i), k, t$$

### **ARAM Typical Results – Risk Comparison**



# Then and Now

### Spring 2017



### Fall 2020



+ Homepage Asset Ava

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### **ARAM Demo**

### • Workflow:

- CONOPS
- Model setup
- Inputting countermeasures
- Notional results

# **ARAM CONOPS**

- Stakeholders input availability of deployable countermeasures
- 2. Hit the "easy button" to obtain schedule of optimal assignments
- 3. Patrol assigned areas per defined stakeholder CONOPS
- 4. View risk buydown and heat maps to evaluate benefits in terms of countermeasure contributions to overall risk reduction



**Typical ARAM Operational Flow Process** 

#### ARAM LOGIN SCREEN

ARAM					
Email Address					
nicholas.betzsold@pnnl.gov					
Password					
Security Code					
842948					
Cancel	Sign in				
A About ARAM	Forgot your password?				

This is a Federal computer system and is the property of the United States Government. It is for authorized use only. Users (authorized or unauthorized) have no explicit or implicit expectation of privacy.

Any or all uses of this system and all files on this system may be intercepted, monitored, recorded, copied, audited, inspected, and disclosed to authorized site, Department of Energy, and law enforcement personnel, as well as authorized officials of other agencies, both domestic and foreign. By using this system, the user consents to such interception, monitoring, recording, copying, auditing, inspection, and disclosure at the discretion of authorized site or Department of Energy personnel.

Unauthorized or improper use of this system may result in administrative disciplinary action and civil and criminal penalties. By continuing to use this system you indicate your awareness of and consent to these terms and conditions of use. LOG OFF IMMEDIATELY if you do not agree to the conditions stated in this warning.



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ARAM	X Sea-Tac							
Port of Seattle	Configuration							
X Airports	Areas Vulnerability Nodes Countermeasures Threats Randomness Factor							
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ARAM	Cargo (Cargo) Cargo							
CONFIG TAB:	Catering (Secured Area) Curbside							
	Checked Baggage Zone (Secured Area) Parking Garage Secured Area - A Gates							
	Checkpoints (Checkpoint) Secured Area - B Gates Secured Area - C Gates							
	Departure Curbside (Curbside)							
	Departure Gates - A Concourse (Sterile)       Secured Area - North Satellite         Secured Area - South Satellite							
Help and Support	Departure Gates - B Concourse (Sterile) Sterile Ticket Counter							
About ARAM	Departure Gates - C Concourse (Sterile)							
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ARAM	X Sea-Tac							
Port of Seattle	n Configuration							
<b>X</b> Airports	Areas Vulnerability Nodes Countermeasures Threats Randomness Factor							
<ul><li>Dashboard</li><li>Heatmap</li></ul>	+ Add VN A Vulnerability Node (VN) is defined as a specific location at which a given secure areas). It is designated by its physical vulnerabilities and is sized to a VNs may affect multiple areas. Select all of the areas that are accesible to e	+ Add VN A Vulnerability Node (VN) is defined as a specific location at which a given threat can be introduced against an area. A VN may provide access to one or multiple areas (e.g., catering services introduces a potential path to multiple secure areas). It is designated by its physical vulnerabilities and is sized to be effectively patrolled by a single countermeasure unit. Learn more VNs may affect multiple areas. Select all of the areas that are accessible to each VN.						
Schedule     Configuration	Sort by Alphabetical •							
H Risk Scores	Arrival Curbside (Curbside)	ering	•••					
👲 Users	Baggage Claim (Baggage Claim)     Area	is accessible by this VN Baggage Claim						
ARAM CONFIG TAB: VN'S	Cargo (Cargo)	Cargo Checkpoint Curbside						
	Catering (Secured Area) Checked Baggage Zone (Secured Area)	Mezzanine Parking Garage Secured Area - A Gates						
	Checkpoints (Checkpoint)	Secured Area - B Gates Secured Area - C Gates						
	Departure Curbside (Curbside)	Secured Area - D Gates						
	Departure Gates - A Concourse (Sterile)	Secured Area - North Satellite Secured Area - South Satellite						
Help and Support	Departure Gates - B Concourse (Sterile)	Ticket Counter						
About ARAM	Departure Gates - C Concourse (Sterile)	Vehicle Access Gate - Secure Area						
	Departure Gates - D.Concourse (Sterile)							



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Port of Seattle	H. Configuration	
X Airports	Areas Vulnerability Nodes Countermeasures Threats Randomness Factor	
Dashboard	+ Add Threat is a natural or man-made occurrence, individual entity, or action that has or indicates the potential to harm life, information, operations, environment, and/or property. Learn more	
✿ Heatmap	Sort by	
Schedule	Alphabetical	
. Configuration		
밝 Risk Scores	Active Shooter	•••
🔔 Users	Chem/Bio	
ARAM	IED	
CONFIG TAB: THREATS	PBIED	•••
	VBIED	
	Workers with Access	•••

About ARAM

Help and Support

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Port of Seattle Seattle Tecome International Apport	the Configuration	
X Airports	Areas Vulnerability Nodes Countermeasures Threats Randomness Factor	
Dashboard	The Randomness Factor sets the amount of random assignments that are produced for scheduling. A higher factor will create schedules that are less optimized, but more unpredictable by adversaries.	
<ul> <li>Heatmap</li> </ul>	10.0%	100
O Schedule		
donfiguration		
👭 Risk Scores		
👤 Users		
ARAM CONFIG TAB: RANDOM ASSIGNMENTS		
Help and Support		
💪 About ARAM		

ARAM	X Sea-Tac	Nick Betzsold 💌
Port of Seattle	II Risk Scores	
X Airports	These are the active risk scores To modify the risk scores, edit them below and then click "Save Changes"	💾 Save Changes
Dashboard	Active Shooter	
⊙ Heatmap	Chem/Bio	
<ul> <li>Schedule</li> <li>Configuration</li> </ul>	ED IED	
tit Risk Scores	> PBIED	
🔔 Users	VBIED	
ARAM RISK SCORES	Workers with Access	
Help and Support		
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Port of Seattle	Active Shooter									
nternanonal Aupont	AREA/VN RISK	со	UNTERMEASURE EFFECTIVENESS							
🗙 Airports	Threat Score Consequence	Threat Score Consequence Vulnerability Detect & Prevent Deterrence								
Dashboard	Consequence of Active Shooter to Are	Consequence of Active Shooter to Area								
<ul> <li>Heatmap</li> </ul>		Economic Impact	Environmental Impact	National Defense	Symbolic Effect	Recoverability	Redundancy			
	Baggage Claim	3.0	1.0	1.0	1.0	1.0	1.0			
() Schedule	Cargo	1.0	1.0	1.0	1.0	1.0	1.0			
Configuration	Checkpoint		1.0	1.0		1.0	1.0			
	Curbside		1.0	1.0	1.0	1.0	1.0			
Risk Scores	Mezzanine	1.0	1.0	1.0	1.0	1.0	1.0			
Users	Parking Garage	1.0	1.0	1.0	1.0	1.0	1.0			
	Secured Area - A Gates		1.0		1.0	1.0	1.0			
	Secured Area - B Gates		1.0		1.0	1.0	1.0			
CORES:	Secured Area - C Gates		1.0		1.0	1.0	1.0			
ONSEQUENCE	Secured Area - D Gates		1.0		1.0	1.0	1.0			
	Secured Area - North Satellite		1.0		1.0	1.0	1.0			
	Secured Area - South Satellite		1.0		1.0	1.0	1.0			
	Sterile		1.0	1.0	1.0	1.0	1.0			
	Ticket Counter		1.0	1.0	1.0	1.0	1.0			
	Vehicle Access Gate - Secure Area	1.0	1.0	1.0	1.0	1.0	1.0			
Help and Support	Chem/Bio									
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ARAM	X Sea-Tac							
Port of Seattle	Active Shooter							
International Airport	AREA/VN RISK	COUNTERMEASURE EFFECTIV	/ENESS					
X Airports	Threat Score Consequence Vulnerability	Detect & Prevent Deterrence	ce					
Dashboard	Vulnerability of VN to Active Shooter 🕜							
<ul> <li>Heatmap</li> </ul>		Availability	Accessibility	Organic Security	Target Hardness			
<b>O</b> o t t t	Arrival Curbside	5.0	5.0		5.0			
() Schedule	Baggage Claim	5.0	5.0	3.0	5.0			
Configuration	Cargo	4.0	1.0		5.0			
	Catering	4.0	1.0		5.0			
Risk Scores	Checked Baggage Zone	4.0	1.0	2.0	5.0			
👤 Users	Checkpoints	5.0	5.0	2.0	5.0			
	Departure Curbside	5.0	5.0	3.0	5.0			
	Departure Gates - A Concourse	5.0	2.0		4.0			
CORES:	Departure Gates - B Concourse	5.0	2.0		4.0			
JLNERABILITY	Departure Gates - C Concourse	5.0	2.0		4.0			
	Departure Gates - D Concourse	5.0	2.0		4.0			
	Departure Gates - North Satellite	5.0	2.0		4.0			
	Departure Gates - South Satellite	5.0	2.0	2.0	4.0			
	FIS/IFA Checkpoint	5.0	5.0	2.0	5.0			
	Food Court	5.0	2.0		4.0			
	Parking Garage	5.0	5.0	4.0	5.0			
Help and Support	Secured Area - A Gates (planeside)	5.0	1.0	3.0	5.0			
	Secured Area - B Gates (planeside)	5.0	1.0		5.0			
About ARAM	Secured Area - C Gates (planeside)	5.0	1.0		5.0			
	Secured Area - D Gates (planeside)	5.0	1.0		5.0			





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Port of Seattle- Seattle-Teoone International Airport	Schedule     shift templates       ✓     ✓       Wednesday, October 21, 2020 曲
X Airports	Timeline     List       Clear Schedule     + Add Shifts
Dashboard	Group by Countermeasures   000 100 200 300 400 500 600 700 800 900 100 100 100 100 100 100 100 100 1
Schedule	No Schedule found for this date
Configuration	
👭 Risk Scores	
L Users ARAM SCHEDULE SCREEN	
e Help and Support	
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ARAM	X Sea-Tac Nick Betzsold V
Port of Seattle- Seattle-Recommendational Airport	< Schedule O Add Shifts
X Airports	Countermeasure Shifts to Schedule
Dashboard	Type     Qty     Shift Date     Shift Start     Shift End     VN Assignment       Select Type     1     1     10/21/2020     0:00     8:00     Let ARAM Decide
	Add another shift
() Schedule	Get Schedule Cancel
L Configuration	
👫 Risk Scores	
Users ARAM SCHEDULE SCREEN: ADD SHIFTS	
Help and Support	
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Port fseattle	< Schedule O Add Shifts						
X Airports	Countermeasure Shifts to Schedul	e					
Dashboard	POS PD Patrol	4	10/21/2020	08:00 AM	12:00 PM	Let ARAM Decide	/ 亩
() Schedule	TSA VIPR Team	1	10/21/2020	06:00 AM	10:00 AM	Let ARAM Decide	
Configuration     Risk Scores	FAM	1	10/21/2020	01:00 PM	03:00 PM	Let ARAM Decide	/ 亩
	• TSI	3	10/21/2020	06:00 AM	02:00 PM	Let ARAM Decide	/ =
SCHEDULE SCREEN:	TSA Canine Team	4	10/21/2020	11:00 AM	06:00 PM	Let ARAM Decide	/ 🗇
ADD SHIFTS							
	Get Schedule Cancel						
Help and Support	× "E	ASY BU	TTON"				

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Port of Seattle- Seattle-Tecome International Asport	Schedule       shift templates         <       >         Wednesday, October 21, 2020 ⊞																								
X Airports	Timeline List																			Cle	ar Sche	dule	+ Ade	l Shifts	
Dashboard	Group by																								
<ul> <li>Heatmap</li> </ul>	Countermeasures •	000	100 20	00 300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	
() Schedule	FAM / 1								:		:	:		:	:			-	3					Ē	
📩 Configuration	Baggage Claim													FAM											
₩ Risk Scores	FIS/IFA Checkpoint														FAM										
🔔 Users	POS PD Patrol / 1																							Ē	
RAM	Arrival Curbside								POS P	D Patrol / 1															
ECOMMENDED SSIGNMENTS	Departure Curbside											POS													
	POS PD Patrol / 2																							Ē	
	Arrival Curbside											POS	)												
	Ticket Counter								POS PI	D Patrol / 2	2														
	POS PD Patrol / 3																							Ē	
Help and Support	Baggage Claim									POS P	D Patrol / 3	3													
About ARAM	Departure Gates - C Concourse								POS																

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Port of Seattle- seattle-zeona International Akport	Schedule       shift templates         ✓       ✓         Wednesday, October 21, 2020 🕮													
X Airports	Timeline List													
Dashboard	Countermeasure 🔺	Area/VN	Arrive	Depart	Shift Start	Shift End	Туре	% Risk Buydown						
<ul> <li>G Schedule</li> </ul>	FAM / 1 💼													
🔒 Configuration	😑 FAM / 1	Baggage Claim	13:00	14:00	13:00	15:00	Optimized	45.24%						
III Risk Scores	😑 FAM / 1	FIS/IFA Checkpoint	14:00	15:00	13:00	15:00	Optimized	44.05%						
🗶 Users	POS PD Patrol / 1 🛛 🛱													
RAM	> POS PD Patrol / 1	Arrival Curbside	08:00	11:00	08:00	12:00	Optimized	86.63%						
ECOMMENDED	POS PD Patrol / 1	Departure Curbside	11:00	12:00	08:00	12:00	Optimized	89.77%						
	POS PD Patrol / 2 💼													
	> POS PD Patrol / 2	Ticket Counter	08:00	11:00	08:00	12:00	Optimized	85.53%						
	POS PD Patrol / 2	Arrival Curbside	11:00	12:00	08:00	12:00	Optimized	85.94%						
	POS PD Patrol / 3 🗂													
<ul> <li>Help and Support</li> <li>About ARAM</li> </ul>	POS PD Patrol / 3	Departure Gates - C Concourse	08:00	09:00	08:00	12:00	Random	87.99%						
	> POS PD Patrol / 3	Baggage Claim	09:00	12:00	08:00	12:00	Optimized	Multiple Values						









## **ARAM Summary**

 Risk-based approach to decide on best use of discretionary resources

• Accounts for multiple threats

 Onity of effort across stakeholder organizations / reduces duplication of effort

Tracks risk and risk reduction trends over time
 Easy to use

### Acknowledgements

• Some of our risk sponsors



Transportation Security Administration







Washington State Ferries



Homeland Security

Science and Technology



For more information, contact:

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