Chart A-1 (IDP perspective)

Quality Characteristics (how)

Customer Demands (what)	Communication coverage	Hazard and vehicle location measurement accuracy	Remote operation	Automatic operation	Level of IVSAWS integration with deployment community systems	Probability of false alarm (Pfa)	High mean time between failure (MTBF)	A rate of importance	N present capability	P- plan	B ratio of improvement	C sales point	D absolute wt.	demanded wt.
Long range alerts (DNA)	9/180	3/60						4	1	5	5	1.0	20	18
Fast alert zone deployment		3/112	9/337	9/337	3/112			5	1	5	5	1.5	37.5	33
Compatibility w/ current systems		1/11	3/32	1/11	9/97			3	1	3	3	1.2	10.8	10
Compatibility w/ current procedures			3/54	3/54	3/54			3	1	5	5	1.2	18	16
Rugged equipment							9/97	3	1	3	3	1.2	10.8	10
Few irrelevant alerts		9/135				3/45		3		5	5	1.0	15	13
Total	180	318	423	402	263	45	97				Total		121	100
%	10	18	25	23	15	3	6							
present capability	1	1	1	1	1	1	1							
plan	5	5	4	3	3	3	3							

Conclusions and Comments:

1. Rate of importance figures based upon IVSAWS market investigation and depoyment community interviews.

2. Present capability (column N) set to 1 since IVSAWS is a new system (no current capability).

3. Remote and/or automatic IVSAWS alert zone activation should receive strong consideration in order to meet stringent law enforcement deployment time requirement.

4. Position measurement accuracy is a key system parameter. (Quality characteristic)

Chart A-1 (Driver perspective)

Quality Characteristics (how)

Customer Demands (what)	Communication coverage	Hazard location measurement accuracy	Vehicle transmission capability	Vehicle location measurement accuracy	Level of IVSAWS integration with other DIS/DNA/DSS	Probability of false alarm (Pfa)	A rate of importance	N present capability	P plan	B ratio of improvement	C sales point	D absolute wt.	demanded wt.
Long range alerts (DNA)	9 / 337	3 / 112	1 / 37	3 / 112	9 / 337		5	1	5	5	1.5	37.5	35
Few irrelevant alerts		9 / 270		9 / 270		3 / 90	5	1	5	5	1.2	30	28
May Day capability	3 / 43	3 / 43	9 / 130	3 / 43	3 / 43		4	1	3	3	1.2	14.4	14
Identify distance to hazards	3 / 45	9 / 135		9 / 135	3 / 45		3	1	5	5	1.0	15	14
Video map w/ hazard and vehicle locations displayed and voice alerts	3 / 27	3 / 27		3 / 27	9 / 81		3	1	3	3	1.0	9	9
Total	452	587	167	587	506	90				Total		106	100
%	19	25	7	25	21	4							
present capability	1	1	1	1	1	1							
plan	5	5	3	5	3	3							

Conclusions and Comments:

1. Communication coverage and level of IVSAWS integration with other advanced driver systems (e.g. DIS,DNA,DSS) are negatively correlated. Strictly speaking, providing long range alerts is beyond the scope of IVSAWS. It is, however a DNA function. Thus, if a vehicle is equipped with a DNA, the communication coverage of IVSAWS can be reduced since the function will covered by another system. However, if a DNA is not resident, the communication coverage of IVSAWS should be extended to provide long range alerts since, based upon the IVSAWS market investigation, this is a strong customer demand.

2. Communication coverage, hazard location measurement accuracy, and vehicle location measurement accuracy are three top IVSAWS system parameters. (Quality Characteristics)

3. Rate of importance (column A) based upon results of IVSAWS market investigation

4. Present capability (column N) set to 1 since IVSAWS is new.

Chart A-2

◎ = strong correlation
O = some correlation
Δ = possible correlation

Quality Characteristics

Functions	Communication coverage	Hazard and vehicle location measurement accuracy	Remote operation	Automatic operation	Level of integration w/ deployment community systems	P_{fa}	MTBF	Vehicle transmission capability	Level of IVSAWS integration with DIS/DNA, DSS	Application of up-to-date standards	Time reference accuracy	Vehicle speed measurement accuracy	
Process driver commands	O	O				Δ	Δ		◎				
Define AOC	O	◎	O	O	◎		Δ	Δ	Δ	O			
Define zone location	Δ	◎	O	O	◎		Δ			O			
Tailor IIS+IIS message		O	◎	O	◎		Δ	O	Δ	O			
Compare vehicle position and AOC	O	◎		Δ			Δ		O				
Alert driver							Δ		◎		O		
Compute DFD		O					Δ		O		O	◎	
Organize and update alerts @ source			O	O	O		Δ						
Organize and update alerts @ vehicle	Δ	Δ					Δ		O	Δ	O		
Generate alert						Δ			◎				

[FHWA N-18]

NOTES:

1. The following quality characteristics have been added via Chart A-2: 1) Application of up-to-date standards, 2) Time reference accuracy, and 3) vehicle speed measurement accuracy.
2. Mean time between failure (MTBF) permeates entire system, but is too vague to be considered a quality characteristic (deleted)
3. Functions were limited to sub-system level of abstraction.

Functions

Chart B-1
(IDP & driver demands combined)

Customer Demands	demanded weight	process driver commands	Define AOC	Refine zone location	tailor IVSAWS message	Compare vehicle position and AOC	Alert driver	Compute DAD	organize and update alerts @ source	organize and update alerts @ vehicle	generate alert @ source					
Long range alerts (DNA)	35	3/105	1/35	3/105		3/105	3/105			3/105	3/105					
Fast alert zone deployment	33		9/297	3/99	3/99				3/99		1/33					
Compatibility w/ current systems	10		3/30	3/30	3/30				3/30		3/30					
Compatibility w/ current procedures	16		3/48	3/48	3/48				1/16							
Rugged equipment	10										3/30					
Few irrelevant alerts	28	3/84	9/252	3/84	1/28	9/252	1/28	3/84	1/28	1/28	1/28					
May Day capability	14	1/14	3/42	3/42	1/14	3/42	1/14		1/14	1/14	9/126					
Identify distance to hazards	14	1/14	1/14	3/42		9/126				1/14	1/14					
Video map	9	3/27		3/27		3/27	9/81									
Voice alerts	9	3/27		1/9		1/9	9/81									
column wt.		271	718	486	219	561	309	84	187	161	352					3348
function wt.		8	21	15	7	17	9	3	6	5	11					
function target cost		*	**	**	**	**/*	*	*	**	*	**					
function actual cost																

* Based upon IVSAWS market investigation, in-vehicle functions should cost drivers a maximum of $450.
** Based upon IVSAWS market investigation, support for infrastructure functions should be limited to $0.62 per capita per year (one-half of current annual budget for hazard/emergency warning devices).
^ police, fire, ambulance, road work, and railroad

1. The three most important functions are infrastructure related. The ratio of total infrastructure function weight to total in-vehicle function weight is 2.0:1. Therefore, it may be argued that substantial IVSAWS infrastructure investment is justified.

2. It is doubtful that in rural areas, $0.62 per capita per year is a sufficient funding base with which to construct, operate, and maintain an IVSAWS infrastructure (i.e. all equipment and operations not integral to privately owned vehicles).

Chart C-2

Mechanisms

Functions	Function weight	transmitter	in-vehicle receiver	driver alert-warning subsystem (DAWS)	geolocation subsystem	transmitter controller	IDP-controller interface						
Process driver commands	8			9/72									
Determine AOC	21				9/189	1/21	3/63						
Determine zone location	15				9/135	1/15	3/45						
Tag or IVSAWS message	7					1/7	9/63						
compare vehicle pos-on and AOC	17			3/51	9/153								
Alert driver	9			9/81	3/27								
compute DAD	3			3/9	9/27								
organize and update alerts @ source	6					9/54	3/18						
organize and update alerts @ vehicle	5	3/15	3/15	9/45	3/15								
Generate alert @ source	11	9/99				3/33	1/11						
receive alert @ vehicle	11		9/99	3/11									
mechanism raw weight		114	114	269	546	130	200						1373
mechanism %		8	8	20	40	9	15						100
mechanism value													
mechanism actual cost													

Comments and conclusions:

1. Geolocation subsystem (relative or absolute) is the most important and valuable IVSAWS mechanism

Chart D-2

Product Failure Modes

Functions	function weight	driver misinterprets alert	driver becomes saturated w/ alerts	improper AOC definition	improper message selection	driver alerted too soon	driver alerted too late	no FCC permission to transmit	deliberate jamming/spoofing	excessive interference (co-channel, adjacent channel, noise, mult. path)						raw wt.	%
process driver commands	8	1/8	3/24													32	2
define AOC	21	1/21	9/189	9/189		3/63	3/63		1/21							546	35
refine zone location	15	1/15				3/45	3/45		1/15							120	8
Tailor IVSAWS message	7	3/21			9/63				1/7							91	6
compare vehicle position and AOC	17		3/51	3/51		3/51	3/51		1/17							221	14
compute DAD	3	1/3				9/27	9/27		1/3							60	4
organize and update alerts @ source	6	1/6	1/6													12	1
organize and update alerts @ vehicle	5	1/5	1/5			1/5	1/5		1/5							25	2
generate alert @ source	11							9/99								99	7
alert driver	9	9/81	3/27			1/9	1/9		3/27	1/9						162	10
receive alert @ vehicle	11								9/99	9/99						198	13
maintain standards*																	
secure FCC license*																	
raw wt.		160	302	240	63	200	200	99	194	108						1566	
% wt.		10	19	15	4	13	13	6	12	7						99	

Comments:

1. The first priority for a product reliability study is "driver becomes saturated with alerts."
2. Increasing the reliability and accuracy of "define AOC" will have the greatest positive impact on product reliability

* newly added functions