



Adaptable Concept

("All Things To All People")

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December 5, 1995

Agenda



- **Goals and Objectives**
- **Physical Architecture**
- **Functions by Layer**
- **Urban Deployment Phases**
- **Urban Deployment Benefits**
- **Rural Deployment End Phase**
- **Rural Deployment Phases/Benefits**
- **Intercity Deployment End Phase**
- **Intercity Deployment Phases/Benefits**
- **Issues**
- **Modeling Wish List**

Goals And Objectives Of The Adaptable Concept (1 of 2)



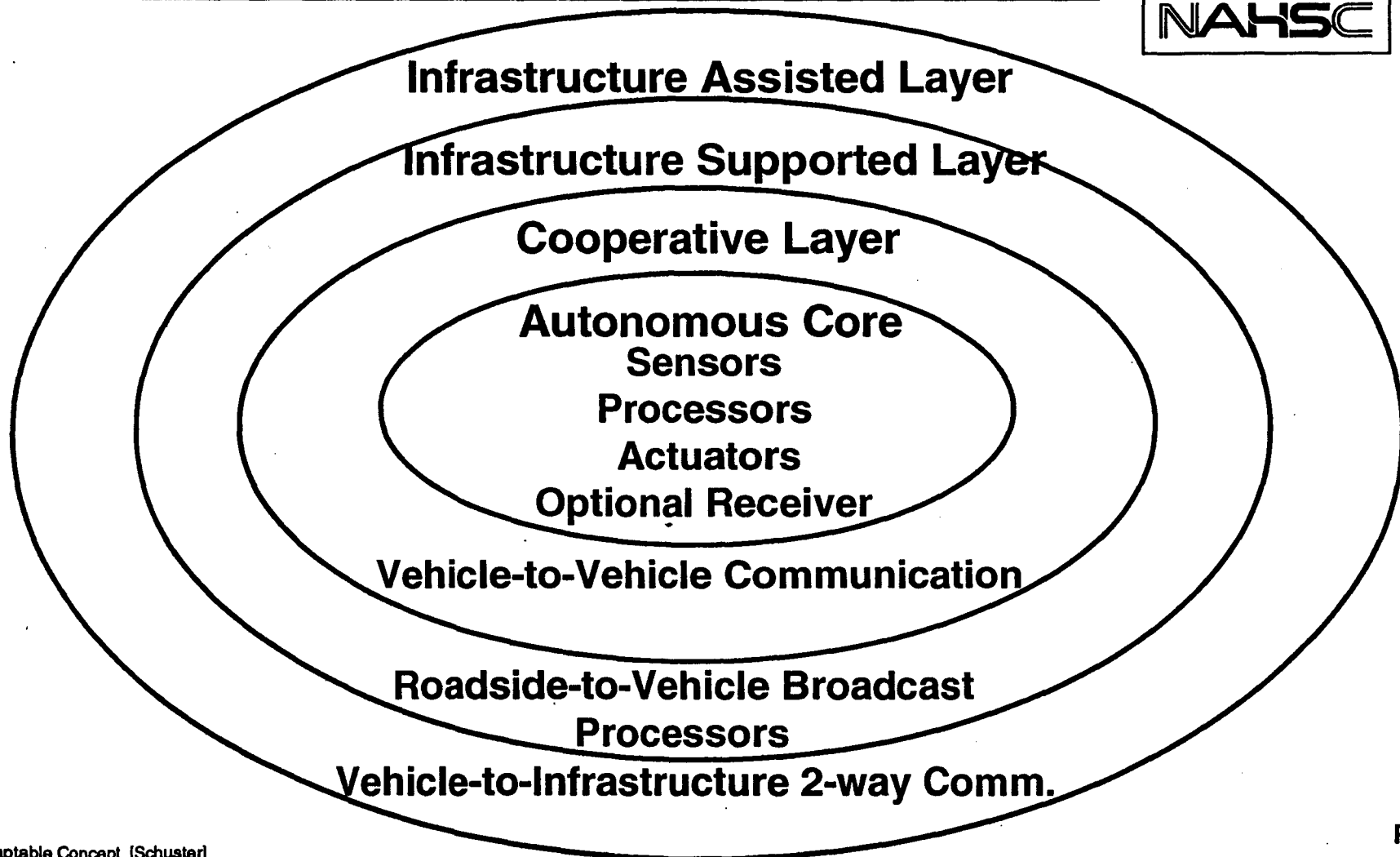
- **Maximize safety and throughput available during degraded operations by providing underlying layers which are stand-alone AHS concepts**
- **Provide a deployment path with steps whose costs and benefits make them credible end-state AHS systems**
- **Design an architecture with sufficient flexibility to meet the needs of urban, inter-city, and rural users**

Goals And Objectives Of The Adaptable Concept (2 of 2)



- **Ensure that transitions during phased deployment or degraded operation occur with minimum cost and disruption of services**
- **Design the concept family so that when a vehicle passes between regions of different population density with different AHS implementations, a smooth transition occurs**
- **Use redundant capabilities in different layers to enhance safety - higher layers override “competing” capabilities in lower layers**

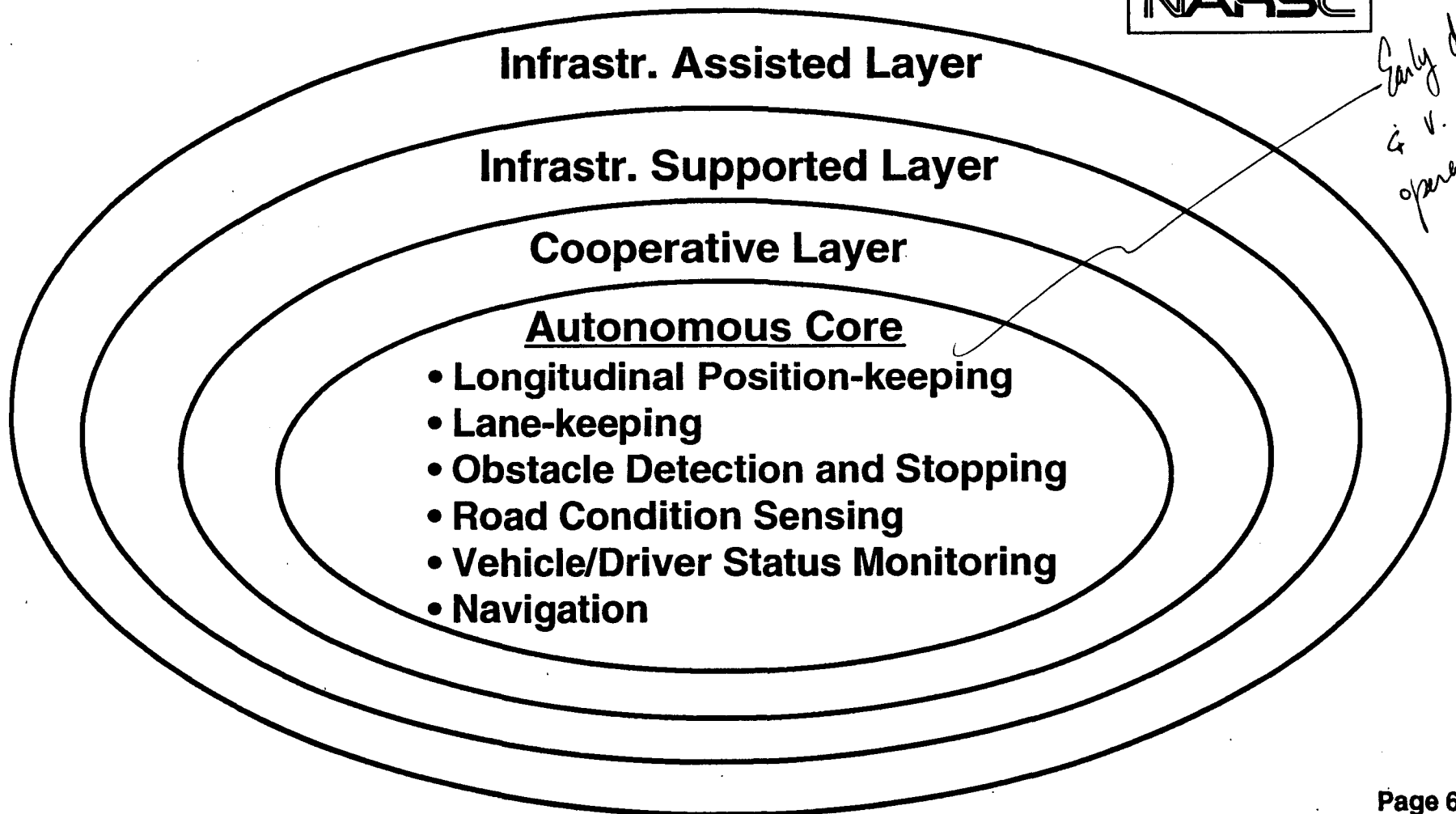
The Adaptable Concept Is Based On A Layered Physical Architecture



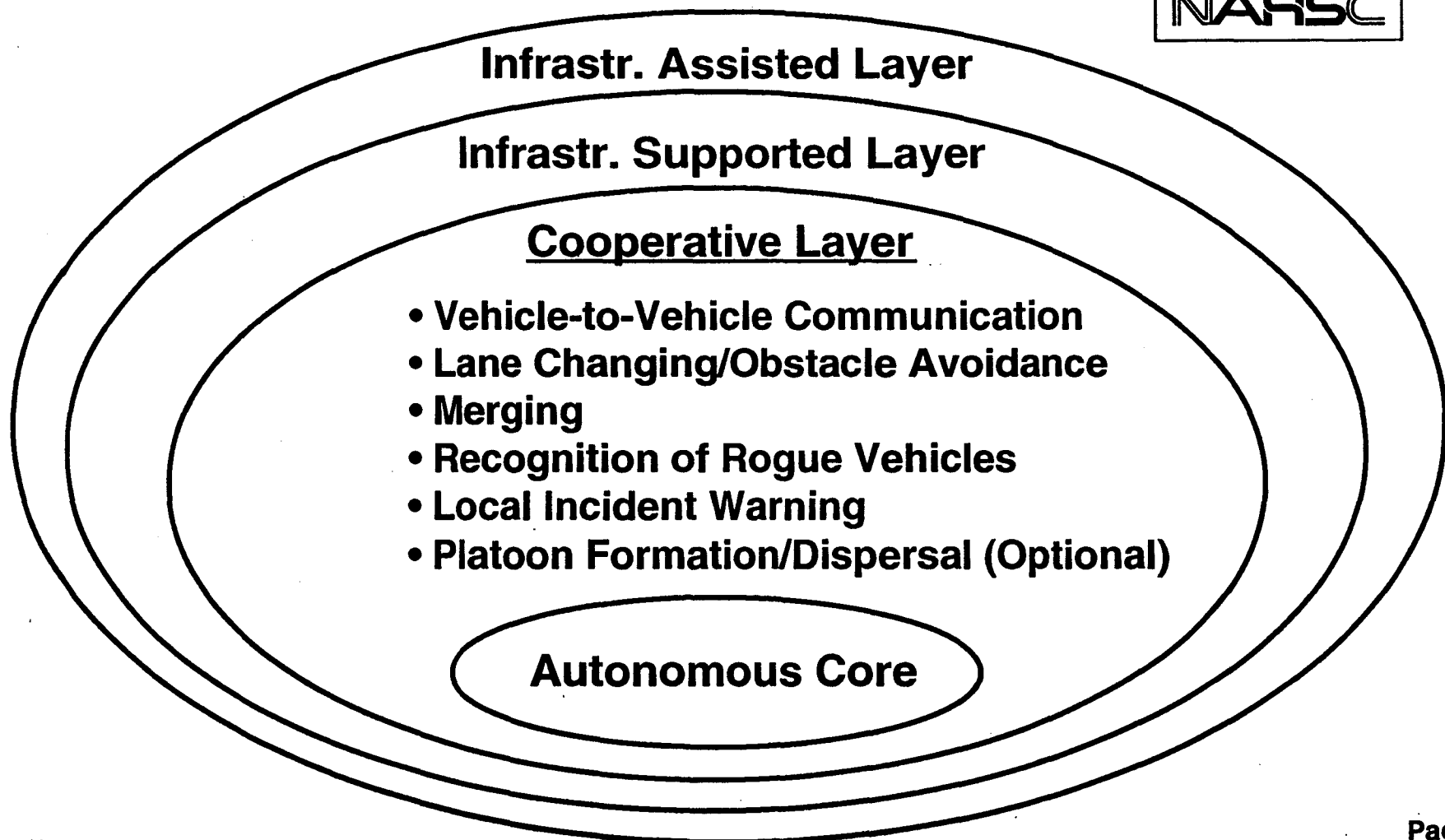
In the Minimal Case, Vehicles Can Operate Autonomously



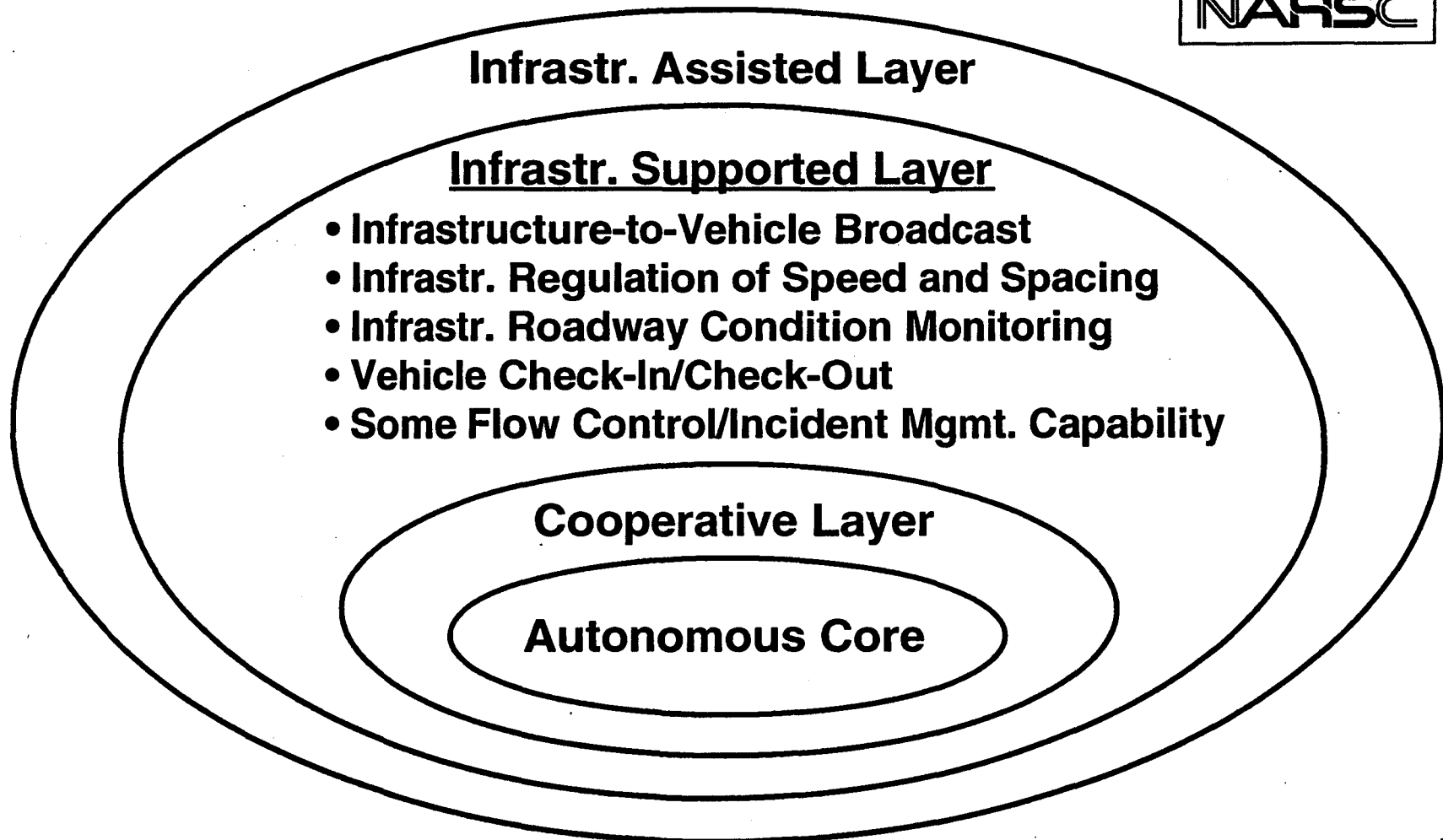
*Early deployment
& v. degrades
operation.*



In The Absence Of The Infrastructure, Vehicles Can Operate Cooperatively



The Infrastructure Supported Layer Provides Most Capabilities



The Adaptable Concept Includes Full Infrastructure Assistance



Infrastructure Assisted Layer

- **Vehicle/Infrastructure Communication**
- **Control of Individual Vehicles**
- **Infrastr. Controlled Lane Changing/Merging**
- **Flow Control and Incident Management**
- **I/C Platoon Formation/Dispersal (Optional)**

Infrastr. Supported Layer

Cooperative Layer

Autonomous Core

Urban Deployment Phase vs Concept Dimensions



Deployment Phase	Dist of Intel	Driver Engag.	Mixing Opt.	Platoon Opt.
Urban 1	Auto	P/E	Yes	No
Urban 2	Coop	Dis	No	Coop
Urban 3	I/S	Dis	No	Coop
Urban 4	I/A	Dis	No	I/A

**Auto - Autonomous; Coop - Cooperative; I/S - Infrastr. Supported;
I/A - Infrastr. Assisted; P/E - Partially engaged; Dis - Disengaged**

Urban Deployment Phases and Benefits



Deploy Phase	Dist of Intel	Driver Engage	Mixed Traffic	Platoon Type
Urban1	Auto	Partial	Yes	None
Benefits - Partial driver disengagement, increased safety				
Urban2	Coop	Diseng	No	Coop
Benefits - Driver disengagement, increased safety, throughput improvement				
Urban3	Infrastr. Supported	Diseng	No	Coop
Benefits - Driver disengagement, increased safety, greater throughput improvement, impr. flow control				
Urban4	Infrastr. Assisted	Diseng	No	Infrastr. Assisted
Benefits - Driver disengagement, increased safety, greatest throughput improvement, impr. flow control				

Possible Rural Deployment, End Phase - Cooperative/Assisted



- **Cooperative system as described in Urban Deployment, Phase 2, plus...**
- **Dedicated AHS lane where practical and economically feasible; mixed with manual otherwise**
- **Infrastructure-assisted merging at major highway junctions, points where AHS lane starts and ends**
- **Roadway/envIRON. condition monitoring and roadside beacon comm. in problem areas**

Rural Deployment Phases and Benefits



Deploy Phase	Dist of Intel	Driver Engage	Mixed Traffic	Platoon Type
Rural 1	Auto	Partial	Yes	None
Benefits - Partial driver disengagement, increased safety				
Rural 2	Coop	Diseng?	Yes	Coop
Benefits - Driver disengagement, increased safety, throughput improvement				
Rural 3	Coop - I/A	Diseng?	Yes	Coop
Benefits - Driver disengagement, increased safety, greater throughput improvement				

Possible Intercity Deployment, End Phase - Infrastr. Support/Assist



- **Infrastructure supported system as described in Urban Deployment, Phase 3, plus...**
- **Dedicated AHS truck lane where practical and economically feasible**
- **Infrastructure-assisted merging at major highway junctions, points where AHS truck lane starts and ends**
- **Infrastructure able to override cooperative vehicle capabilities (e.g., vehicle merging)**
- **Cooperative platooning option**
- **Dedicated AHS lane, check-in and check-out**

Intercity Deployment Phases and Benefits



Deploy Phase	Dist of Intel	Driver Engage	Mixed Traffic	Platoon Type
Intercity 1	Auto	Partial	Yes	Truck w/ P/E Lead Driver
Benefits - Partial driver disengagement, increased safety, increased truck driver productivity				
Intercity 2	Coop	Diseng	No	Coop
Benefits - Driver disengagement, increased safety, throughput improvement				
Intercity 3	I/S - I/A	Diseng	No	Coop
Benefits - Driver disengagement, increased safety, greater throughput improvement				

Issues



- **Can an autonomous vehicle change lanes without driver intervention?**
- **Will stopping on obstacle detection result in an unacceptable number of accidents?**
- **Is cooperative feasible in mixed traffic?**
- **Will AHS on rural highways be mostly dedicated lane or mostly mixed traffic?**
- **Can Urban Phase 1 deployment sites be selected to minimize the need for lane changing and merging?**

Adaptable Concept Modeling Wish List



- **Mixed traffic/dedicated AHS lane/separate AHS car and truck lanes**
- **Manual/infrastructure assisted lane changing and merging**
- **Cooperative/infrastructure directed platooning**
- **Communications to support: cooperative/infrastructure supported/infrastructure assisted**
- **Incidents/obstacles/road surface conditions**
- **Vehicle/infrastructure monitoring of road surface conditions**